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NEW YORK, FEBRUARY, 1895.

## EDITORIAL NOTES.

The paper on the application of water-tube boilers to warships is concluded in this issue, and contains such valuable conclusions that we call the attention of our readers to the matter as being one especially worthy of notice. The writer is evidently of the opinion that the advantages of this type of boiler so far outweigh those possessed by boilers of the ordinary construction, that they cannot fail of an ultimate adoption on all vessels.

On the principle that misery loves company, it may be a sort of melancholy satisfaction to the naval authorities of the United States and Great Britain that they are not the only ones that have had trouble with unstable warships. It seems that the French Navy are in a similar predicament, and that the battleship *Magenta* is now undergoing some costly alterations that have been deemed necessary on account of its remarkable behavior at sea. The strange part of it is that the French builders have, after the defects were discovered, made apparently the same mistake with the battleship *Brennus.*

The Carnegie Company seem to be in luck again. Their first luck consisted in the remittance of a part of the fine that was imposed upon them for underhanded work in the matter of certain armor plates, regarding which there has been somewhat of a scandal. Now a Washington despatch states that a plate representing a group of plates for the *Oregon* was submitted to a ballistic test at Indian Head and failed to pass, whereupon the whole group was rejected. Then an investigation was held, and it is asserted that it was found that the test was more than the ordinary service charge, and that the plate was weaker than those that it represented; so the Secretary has decided to accept the plates, especially as the Government agent at the works asserts that the remainder of the plates will come up to the requirements.

To the ordinary visitor it would appear that the battleship of modern construction is about as near fire-proof in its construction as it is possible for it to be. It seems, however, that there is room for improvement in this direction. The Yaloo fight showed that there was considerable danger yet remaining from the use of wood, and several of the Chinese ships were badly crippled during the battle by fire. Investigations are therefore being made to ascertain whether it will not be possible to lessen the amount of wood that is used. It is proposed that the ceilings and sides of the living spaces of the vessels shall be lined with iron or *papier mache*, or some other substance that is less inflammable than wood; that iron ladders shall be substituted in the place of wood; and that the facilities for the storage of inflammable materials shall be improved as well as those for extinguishing such fires as may occur. It is a factor deserving of careful attention, but in making such substitutions equal care must be exercised that danger from dampness is obviated as well as the danger from fire.

When the question of an increase in the number of large vessels in the navies of the United States or Great Britain is under consideration, the party favoring such an increase has usually been divided into two camps—one advocating the construction of heavy battleships whose speed is comparatively slow, and the other urging that a high-speed cruiser will be most efficient in time of war. As there had never been a battle fought between modern battleships until the Yaloo fight in the Chino-Japanese War, there has been no means of deciding as to which party was in the right. That fight seemed to demonstrate very clearly that intelligence and discipline have about as much to do in the deciding of naval battles as they ever did, but the question of battleship *versus* cruiser cannot be said to have been definitely settled, on account of the evident fighting superiority of the Japanese forces. In the report of the engagement submitted to the Navy Department, it is asserted that the Chinese heavily armored ships were practically uninjured by the Japanese fire, which is considered as tending to bear out the arguments in favor of the battleship as against the cruiser, and it is expected that it will be offered as such to the Naval Committee.

## THE SCRAP PILE.

At the November meeting of the Western Railway Club, Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway, read a very interesting and what ought to be a very profitable paper to many railroads, the purpose of which was to indicate how the material which has failed and is sent to the scrap-pile may be utilized to best advantage. As Mr. Barr has well said, "In hundreds of ways the scrap-pile tells the story of thrift and intelligence, or the reverse, on the part of the men who have charge of the mechanical work along the line of a railroad." He might, and in substance did add to this the statement that the thrift and intelligence of those who have charge of the mechanical work may also be indicated by the uses which are made of this material after it has been condemned. The general purport of his recommendations was, that the miscellaneous material which goes into the scrap should be assorted and classified, so that it will be available for such uses as it is adapted for. To carry out this idea, he recommends that "all material unfit for further use should be shipped to one central point, which should be located at the main shops, and such as

can be profitably converted into good material or can be used again should be separated from that which is merely scrap.

It was pointed out in the discussion that it was useless to preserve all kinds of scrap for further use, if it was kept in a confused heap or scattered about, so that when any particular thing was needed more time had to be spent in finding it than the material was worth after it was found. One speaker (Mr. Waitt) related that the foreman of the blacksmith department of the shop of which he first had charge "was all the time saving pieces of round and square iron, piling them up, supposing he was placing them where he could lay his hand upon them, but whenever there was use for an article he had, he never could find it." He, Mr. Waitt, "at last came to the conclusion that it would be better to clean out the accumulations of months or years, rather than to spend two cents to get one and a half out of it." Other speakers called attention to the same aspect of the question. Mr. Forsyth thought that any effort to classify scrap and get it into shape for market results in the scrap being handled quite a number of times, and there is the danger that the cost of the labor expended on it will equal the value of the material. Mr. Barr himself, the author of the paper, said that the cost of handling material must be carefully watched, and cited a case of their effort to make hand-hammers from old Krupp tires. They cost $8.98 per dozen, whereas new ones could be bought for $4.50 per dozen.

A short time ago the *Iron Age* published an article containing some calculations with reference to the value of wire nails and of a carpenter's time, in which it was shown that such nails were now so cheap that it did not pay to have a workman pick one of them up if he let it fall, as the time consumed in picking it up was worth more than the nail. This same principle may apply to the utilization of scrap, and it is evident that to make a profit by re-using old material which has been condemned, a good deal of horse sense or business ability must be exercised. The value of Mr. Barr's paper consists chiefly in his description of the special means and methods which he has adopted and which he has found were economical. Of these he says:

"In handling bolts, for example, a bin is required in which all bolts are deposited as unloaded. The crooked bolts are taken to the blacksmith shop to be straightened, and they and all straight bolts are then taken to the storage bins. These bins are divided into compartments, so that all old bolts of the same diameter, and which will make good bolts of equal lengths, are placed in one bin. These compartments are all labelled. For example, there is a row of compartments carrying bolts 1 in. in diameter. The first one is labelled 1 × 15 in., which is the longest bolt in general use. The next is labelled 1 × 14 in., and so on down to the shortest bolt in use. All bolts which by trimming and recutting can be converted into a good bolt 10 in. long and no longer are placed in the compartment labelled 1 × 10 in. The bolt itself may be longer than 10 inches, but the necessary trimming will bring it to that length.

"The bolt bins are located conveniently to the shop in which the machinery for cutting round iron and threading bolts is located. When the shop receives an order for, say, 100 bolts 1 × 10 in. in length, 100 bolts are taken from the compartment labelled 1 × 10 in. These bolts are taken to the shears, and if any longer than 10 in., the surplus metal is sheared off. They are pointed and threaded, and are then in shape to be shipped. It should be observed that in handling bolts in this way the expense of heating and heading is avoided, and this expense nearly if not quite offsets the cost of handling and straightening the old bolts, so that the difference between the cost of bolts obtained in this way and bolts made from new material is just about the difference between the cost of new round iron and scrap."

The short ends of bolts are manufactured into track bolts, and it is proposed to erect a set of small rolls for the purpose of re-rolling various odd sizes of iron, and reduce them to one diameter, which would be most desirable for ordinary use.

Nuts are also assorted, and as many of these have had their threads injured, it is necessary to retap them. To do this they must be compressed sideways in order to get a good thread. Dies have been fitted to a bolt-heading machine for this purpose. The nuts are then pickled in a weak solution of hydrochloric acid to remove rust and thus prevent undue wear to taps. The results of handling nuts in this way have, however, not been as satisfactory as is the case with bolts, but Mr. Barr was of the opinion that a large supply of nuts could be obtained in this way at a lower cost than that of new ones.

Crown-bar washers have also been made successfully from old material, and centre pin-plates in sufficient number for all new cars can be obtained from scrap sheet iron if this is straightened and sheared to the right size. Sheet iron is assorted with reference chiefly to its thickness, but also to its condition, and it is thought that a supply of washers could be obtained from this material if suitable punches for making them were provided. Mr. Barr also expressed the opinion that a small set of rolls for re-rolling plates to the required thickness would be a useful adjunct to the scrap department. His general recommendations are that the scrap-pile should be placed in charge of intelligent persons, the scrap should be systematically assorted, and the requisite appliances for handling and "rejuvenating" the scrap economically should be adequate for the purpose for which it is intended.

In the discussion which followed the reading of the paper, objection was made to the expense of a furnace of sufficient length to take in the iron that would have to be rolled down. To this the author of the paper replied that he could not see why the iron should not be cut to convenient lengths, which would permit of the use of medium furnaces if this were more convenient. Mr. Barr also explained that since his paper had been written they had improved their methods of "rejuvenating" nuts. Previously their treatment of old nuts did not show that any money was saved. He had, however, taken a bolt-heading machine and removed all the levers which operated the dies, leaving the one plunger which upsets the head. "The machine was so arranged that this plunger forces the nuts through a hole in a die, and presses them to size just as fast as the boys can drop the nuts into position." Mr. Barr also called attention to the fact that many things were sent to the scrap pile which were perfectly good for further service, and he recommended that more diligence and care should be exercised by those who condemned material and sent it to the scrap pile. He cited the case of broken bolts with good nuts on them—the bolts should be scraped and the nuts saved.

Mr. Manchester, an assistant of Mr. Barr's, related their experience and difficulty in using up old tires. Making hammers of them did not prove to be profitable, but they are now making certain dies and forms used in and around the blacksmith shops, and such articles as spike mauls, coal hammers for locomotives, lining-bars, claw-bars, and some kinds of wrenches have been made at a profit out of scrap steel tire.

In the case of coiled springs, they had condemned the bad coils in a set and saved the good ones, and were thus able to form complete good sets. From old double-elliptic springs they had been stamping small wrenches, spindle kegs, equalizer fulcrum plates and other small articles, but not enough to use up all the condemned springs. Recently he had been making track plates of them—that is, plates on which the movable rails of switches bear. They made an arrangement with which they sheared the plates in a "bull-dozer" and punched two square holes in it at one operation, the plates being heated for that purpose. Old flues they are using for making the gratings of cinder-pits, which are used for clean-

ing out the smoke-boxes of locomotives, and are thereby effecting a saving of 50 per cent. over what they cost if made of new material, and the tubes make better grates than those made *de novo*.

Old fish-plates are made into rail braces; broken centre pins are re-welded; crooked links, which are not cracked, are straightened. "All scrap when it arrives is assorted and sheared to proper lengths for what it will make, and it is then piled with the iron that is to be used for that purpose. At West Milwaukee the scrap-pile is so arranged that all scrap material that is to be used in forging is laid out in alleys, in such a way that one class of iron and size of iron is put together, and consequently if there is a piece of scrap iron on hand a blacksmith can find it and get it as readily as he could get a new bar out of the iron house. The blacksmith foreman and iron-house foreman are thus as well acquainted with the iron on hand in the scrap department as they are with the new iron in the storehouse.

Mr. Peck thought that more saving could be effected by watching and preventing the careless scrapping than by working over old scrap. If a shop is equipped with shears, it is all right; but if you have to do the work by hand, as small shops must, it does not pay.

Mr. Hatswell said that on his line old bolts are returned to the scrap department and are then straightened and cut to standard lengths, and are used over again if they are fit for such use. Old nuts he put into a furnace and reheated and then soaked them in oil. He had made taps of case-hardened wrought iron, and run these taps through the old nuts, which made the old nuts as good as new ones. He said further that in one of the shops of their car department between 50 and 60 per cent. of all metal work used is second-hand material, and one shop had used as much as 90 per cent.

All this sounds very much like old-fashioned economy, and as the speaker last quoted remarked, "It seems rather curious that at this late date we begin to find out that a railroad has a scrap-pile." The interesting fact is that it seems as if considerable amounts of money can be saved by the exercise of some diligence and intelligence in the disposal of the contents of what may be regarded as a sort of purgatory of old railroad material.

## FUEL CONSUMPTION BY LOCOMOTIVES.

At one of the meetings of the Western Railway Club, from the reports of which we have quoted so liberally in the preceding article, Mr. William Forsyth, of the Chicago, Burlington & Quincy Railroad, read a paper on Locomotive Fuel. In that report he says it was his intention to investigate the progress which has been made in coal burning on locomotives in the past ten years, with respect to boiler construction, fire-box, grate and draft appliances, as well as methods of firing. It was his intention, he says, to compare the work done in hauling trains by one ton of coal in 1883 with the same work in 1893. He was deterred, however, by the fact that the discussion of the composition of coal, which formed the first part of his paper, had already made the paper too long, and that the difficulty of getting exact data for such a comparison is very great, and, in many cases, impossible. His hearers and readers, it is thought, will regret that he did not carry out his intention, and they will entertain the hope that he may be induced at some time in the future to carry out his purpose in that direction. He supplements his paper with a few suggestive statistics, such as a statement of the fact that within the past decade the coal consumption per car per mile on his line of road has increased from 5¼ to 6¼ lbs., or 18 per cent. No data are given to show the relative average weight of cars now as compared with what it was ten years ago. He shows, however, that the difference in fuel consumption in different classes of engines is very great. Thus 40 Class A 17-in. engines, with 17.6 sq. ft. of grate area and deep fire-boxes between the frames, burned 6.32 lbs. of coal per car per mile in 1893, while 40 Class H mogul engines, with 27.6 sq. ft. of grate area Belpaire boilers, with fire-boxes above the frames, burned only 4.61 lbs. of coal per loaded freight car per mile. No other data about the engines is given, excepting the statement that the H engines are heavier than the others. Fuller dimensions and descriptions of these engines would have been interesting to those not familiar with the equipment of the Chicago, Burlington & Quincy Railroad. Nothing is said either of the relative train loads. It is said though that the difference of fuel consumption in favor of the heavier engines was 37 per cent., from which the inference would be that the train loads were larger with the heavy engines.

Some interesting figures are also given showing the variation between the performance of different engines of the same class in the same service. For the A engines the maximum is 9.66 and the minimum 4.62 lbs. per car per mile, a variation of more than 100 per cent. For the H engines the maximum is 6.81 and the minimum 4.06, a variation of nearly 60 per cent. Their compound H engine burned only 3.27 lbs. per car per mile. In 1883 the average grate area per engine was 16.37 sq. ft., while in 1893 it was 18.95 sq. ft., an increase of 15.7 per cent.; nevertheless the records of the whole road show an increase of 18 per cent. in fuel consumption per car per mile. Not knowing the relative average weight of cars in 1893 and in 1894, of course no inferences can be drawn of the proportionate fuel economy then and now, but these data make it appear somewhat doubtful whether much advance has been made in that direction.

Mr. Forsyth suggests the following lines of inquiry:

1. Are we making any progress in economical coal burning?
2. How can it be most easily and exactly shown from yearly accounts?
3. What is the best method of showing fuel consumption so as to properly grade the performance of the engine-men?
4. Will it pay to keep records in sufficient detail to show what we are actually doing in this direction?

To the latter inquiry we would give an unqualified yes for an answer; but there is room, we think, for doubt about the wisdom of spending much time or thought in ascertaining the relative economy of old and more or less antiquated forms of engines. Of course they should be made to do as good service as they are capable of doing, but the question which most managers are most anxious to know is what kind of engines are the best adapted to and will be the most economical in different kinds of service. Nearly every locomotive superintendent is ready to advocate the merits of *his* "standard" form of engines for the service in which they are employed. Now it would be extremely interesting if once in a decade, or perhaps oftener, a national test of a few of the leading types of locomotives could be made under uniform conditions, in which each could show the best it could do. If any one type of engine possessed marked points of superiority, it would certainly appear in such a test.

## NEW PUBLICATIONS.

"New York Railroad Men," a Monthly Publication Devoted to their Interests. Published by the Railroad Branch of the Young Men's Christian Association of New York.

This journal comes to us in a new dress and attractive form. The size is that of the ordinary popular magazine, and the number before us contains 18 pages of excellent reading matter relating to the work of that Association. "Our purpose," the editor says, "is to benefit railroad men by adding to their fund of information, by advocating morality and religion, by

opposing wrongdoing in every form so far as it relates to them; to champion the cause of the Young Men's Christian Association as an agency of proven value in promoting their welfare, and by seeking to exalt manly virtue, faithfulness and intelligence in the performance of duty and true character as the surest way to obtain permanent success." To all of which we say, Amen.

"LOCOMOTIVE ENGINEERING" (New York) also comes newly clothed. Its pages are now 9 × 12 in., which size is one of the standards proposed for publications by the Master Car Builders' Association. As usual, it is full of illustrations and descriptions of all kinds of appliances relative to railroad and locomotive work.

THE TRADESMAN ANNUAL, No. XVI, containing 218 pages, is filled from one end to the other with contributions from many writers relating to the main industries and chief resources of the Southern States. The number is a sort of encyclopædia of these subjects. It is elaborately illustrated, and contains besides a list of over 5,000 names and addresses of persons, firms and companies engaged in all lines of industries in that section.

STRESSES IN GIRDER AND ROOF TRUSSES, for both Dead and Live Loads, by Simple Multiplication, with Stress Constants for 100 Cases, for the Use of Civil and Mechanical Engineers, Architects and Draftsmen. By F. R. Johnson, Assoc. M. Inst. C. E. London and New York: E. & F. N. Spon, 1894.

This little book contains seven pages of text and 140 pages of tables, the text being hardly as much as a full explanation of the tables. The tables simply give coefficients, which, when multiplied by an assumed unit of load, give the strain in each member for a number of skeleton trusses and skeleton roofs. They would not be applicable to trusses of different proportions, and while they may be very useful to the author, if his practice calls for a repetition of structures of these lines, it is not likely that they would be of much use to any one else. In the present American practice, where the calculation of strains in skeleton structures is well understood, and where the forms of skeletons are constantly varied to adapt them to individual cases, these tables would be practically useless. They may be valuable where material is cheap and designers are without education, but they are not valuable to the educated designer who is studying to economize material.

A TEXT-BOOK OF MECHANICAL ENGINEERING. By Wilfrid J. Lineham, head of the Engineering Department at the Goldsmiths' Company's Institute, New Cross, London. Chapman & Hall, Limited. 772 pp., 5¼ × 8 in.

At last we have a good book on mechanical engineering, one which can be recommended to students and apprentices with little reserve. Considering how great the interests are which are included under the general heading of Mechanical Engineering, it is surprising that a book of this kind has been so long in appearing. In his preface the author says that his aim was to furnish "a comprehensive work which would at least show students the general lines on which their study as engineer apprentices should proceed." In seeking to do this, he says further, he had "to consider seriously whether the whole theory and practice of mechanical engineering, or even a *précis* of it, could be compressed into one volume, and whether it was desirable so to compress it." He has attempted to do this, and the book therefore covers a very wide field, many portions of which necessarily could not be very thoroughly cultivated. Still it is remarkable that so much could be compressed within the limits of one book, and what is given is excellent. There are no indications of that bane of technical books, "collation"—that is, of a collection and comparison of what has been written by others on the subject, and then making a more or less weak solution by mixture with the author's own views and opinions. The engravings in the book are numbered up to fig. 732, and we have not been able to detect a single instance in which it was apparent that advertising engravings taken from trade catalogues had been made to do double duty by being reprinted in the book before us. The illustrations all appear to have been original drawings, made especially for the purpose for which they have been used. Some of these, however, are not quite up to the standard which might be expected in a book of this kind, written by a professor in a technical school, a special function of which is to teach mechanical drawing. The only harsh criticism for which there is any opportunity is in relation to some of the illustrations. Some of these—particularly in the beginning of the book—appear to have been made by immature students, and besides this defect, they are execrably engraved, for which, in these days of cheap "process" work, there is no excuse. Both the drawings and the engravings improve as the pages advance; and it appears as though the draftsman who made them had been gaining in skill and practice in doing the work for the author. In his preface he takes especial occasion to thank the firm who made the "bulk of the zincographic blocks" for the reproduction of the drawings. A little vituperation might with justice have been added to this commendation. If the engravings on pages 8, 9, 16, 35 and 73 are deserving of praise, the art must be at a very low ebb in England.

The reviewer having allowed the wrath of a mechanical draftsman to vent itself, now finds occasion only for commendation of the book. It is divided into two main parts, the first relating to Workshop Practice and the second to Theory and Examples. The first contains chapters on the following subjects: Casting and Moulding; Pattern-Making and Casting Design; Metallurgy and Properties of Materials; Smithing and Forging; Machine Tools; Marking-off, Machining, Fitting and Erecting; Boiler-Making and Plate Work. The second part, in separate chapters, treats of Strength of Materials, Structures and Machine Parts; On Energy, and the Transmission of Power to Machines; On Heat and Heat Engines; Hydraulics and Hydraulic Machines.

In the space and the time which is available a review of this book is very difficult, and must be very inadequate. The author's method of treatment of the subjects he discusses can be shown by summarizing the first chapter on Casting and Moulding. In this he begins by describing cast iron and its characteristics, chemical composition, and the method of melting it, with a description and engravings of a cupola. After some general observations on moulding, moulding-boxes—or "flasks," as they are called in this country—are described. Moulding sand and its different qualities and uses are explained, and the general methods of moulding in loam, open sand, and with patterns and moulding-boxes of various kinds are fully illustrated and described in the most admirably clear way. The illustrations—excepting their graphic execution—are excellently suited to illustrate the subjects they are intended to elucidate. The objects which are selected for the purpose of explaining how they are moulded are a cattle-trough, a hand-wheel, a chain-pulley, a worm-wheel, a drilling-machine table, a cylinder head or cover, a traction engine road wheel, a gas-pipe main and bend, a steam cylinder with its cores and core-boxes, a screw propeller, a fly-wheel, an air vessel, cone pulley, stop-valve, and plummer block. Sectional views of these are shown in the sand, and illustrations are given of the cores and core-boxes, the method of parting of the flasks, and of striking or sweeping moulds for a steam cylinder cast in loam. The appliances used are shown in great detail, and the explanations are excellent. Illustrations are also given of a wheel-moulding machine, and the methods of moulding wheels with such machines are described. The process of making chilled castings is illustrated by sectional views of a cast iron car wheel and a chilled shot shown in the sand. The method of making and annealing malleable castings is described, and the construction of an annealing furnace is illustrated with an engraving. Brass founding is treated in a similar way, and descriptions and observations are given with reference to the construction of "gates," cores, and moulders' tools. The chapter ends with some descriptions of mixtures of cast iron and observations on steel castings. It contains in all 52 engravings, which are admirably designed for illustrating the subjects to which they relate; but, as remarked before, some of them are execrably engraved.

The subject of pattern-making is treated in a similar way, and contains 31 engravings.

In the third chapter the characteristics of various kinds of metals and the method of their manufacture are very concisely described.

The chapter on Smithing and Forging occupies 49 pages and contains 37 figures, many of them with a half dozen or more separate details. Folded plates are also given showing arrangement of a "smithy," views of a steam hammer, and an excellent "Tempering Table" printed in colors, and showing the tints to which steel should be heated to produce different degrees of temper or hardness. The methods, tools and appliances which are used for producing forgings of different kinds are discussed in great detail but in a condensed and concise way, so that the reader is never wearied by iteration.

Chapter V, on Machine Tools, as might be expected, is a long one, and occupies 46 pages and contains 62 engravings, among them large folded plates of several kinds of lathes, a boring, a drilling, a planing, a shaping, a slotting and a milling machine. The uses of these machines are very fully described.

Chapter VI, on Marking-off, Machining, Fitting and Erecting is equally full and complete, and illustrations and descriptions of all the well-known shop tools, and of many that are not well known, are given, and their use is fully described. It should perhaps be explained that the illustrations of these tools and machines do not represent conventional appliances of a more or less antiquated design, but they are obviously made from appliances in actual use, which are generally of the most approved and latest design. The remarks apply also to the chapter on Boiler Making and Plate Works, in which some processes, machines, tools, and appliances are described which will probably be new to many American mechanics; and there is probably no chapter in the book which they can read to as much advantage as this one. The illustrations and descriptions of hydraulic machine tools for boiler work (Plates XV and XVI), and also the hydraulic flanging machine (figs. 289 and 290), will be of especial interest to many American readers. Other hydraulic machines and tools are described, and the comparative speed and cost of hand and machine riveting are discussed and illustrated by diagrams; electric welding is also given a place in this chapter; and the "geometry required by the boiler maker" is described, and the methods of laying off plates for boilers is explained. This chapter ends Part I, and up to this point little or no mathematics will be found in the different explanations.

In Part II, on Theory and Examples, mathematics are freely used. Many readers will be in full sympathy with the author when he says—as he does in the preface—that while he has never introduced mathematics unnecessarily, when he has he has "stated all the 'steps' that space permitted in such mathematics as have been introduced, and the latter will be found of but an elementary character, involving only simple equations, fractions, and the use of tables of sines and logarithms."

Part II opens with a Synopsis of Lettering adopted in this Part. This gives a list of letters or mathematical symbols and what they are used to represent, which will save the reader much perplexity in studying and applying the formulæ which are so liberally used in the second part of the book.

In a notice of this kind but little can be done but to speak in a general way of the treatment of the subjects which the author has attempted to elucidate. The deficiency which the general reader will encounter in this part is that the subjects discussed are not sufficiently explained. This will be particularly the case with readers who are poorly equipped by previous technical training and education to comprehend explanations which are necessarily condensed into a form which will often approximate to a condition of incomprehensibility. A mere enumeration of the subjects which are elucidated in the second part of this book would probably occupy a whole page of the American Engineer, if set in closely printed type. Necessarily but little space could be given to each. Thus, the Strength and Testing of Materials; Testing Machines; Stress-strain Diagrams; Strength of Chains; Ropes, Pipes, Cylinders, Fly-wheels, Bolts, Links, Riveted Joints, Pins and Bolts, Colter Joints, Solid and Hollow Shafts, Couplings, Coupling Keys, and Springs; Theory and Strength of Beams of different kinds, Axles, Crane Hooks, etc., Columns, Connecting-Rods, Furnace Tubes and Crank-Axles; Theory of Braced and Framed Structures, including Roof Trusses, Suspension Bridge Chains, Warren Girder, Jib Cranes and Wind Pressures are all discussed in Chapter VIII, which contains 112 pages. Naturally the explanations and treatment of these subjects are more or less inadequate, and the reader who goes to the book for the elements of the subjects discussed will have much difficulty in comprehending what the author has attempted to teach. It is remarkable, though, how much he has managed to condense into his pages. The eighth chapter, on Heat and Heat Engines, which contains 130 pages, is remarkable in this respect. It ranges over the whole field comprehended by that title, including the Theory of Heat; Pyrometers; Thermodynamics; Losses in Steam Engines; Cylinder Condensation and Re-evaporation; Theory of Compounding; Steam Engine Indicator; Topography of Indicator Diagrams; Single, Double and Triple Expansion; Combination Diagrams; Various Forms of Steam Engines; Slide-Valves; Relation of Crank and Eccentric; Reversing Gear; Valve Gears; Governors; Variable Expansion Gear; Marine Governors; Zenner's Valve Diagram; Ideal Diagrams for Compound Engines; Correction of Indicator Diagram for Inertia; Curves of Crank Effort; Weight of Fly-Wheels; Pumping Engines; Triple-Expansion Marine Engines; Locomotives, including Springs, Brake, Boiler, Traction Force, Safety Valves, Gauges, Injectors, and Forced Draft, Gas and Oil Engines.

The treatment of all of these subjects is admirable, but necessarily condensed to a form resembling the "pocket-book" style of treatment. As an example of the author's style we will give what he says under the head of the Losses in Steam Engines. These, he says, are:

1. Steam is not supplied at the temperature of the hot body (furnace).
2. Steam is not rejected at the condenser temperature and pressure, but falls as regards both when leaving the cylinder.
3. The feed-water has its temperature raised in the boiler instead of being originally at the temperature of the steam.
4. The expansion should be adiabatic, as in a non-conducting cylinder, but it varies considerably from this.
5. The steam should be compressed from condenser temperature to boiler temperature. It is, however, only compressed through a portion of this rise, the rest being obtained by heat supply from the boiler.
6. Clearance in cylinder being unavoidable, must be filled by steam at each stroke, which does no work during "full-pressure" period.
7. The boiler "primes" more or less—that is, sends water particles to the cylinder along with the steam, which pass to the condenser without doing work, or, still worse, abstract heat from the cylinder steam in their endeavor to vaporize.
8. The limits of working temperature are small in comparison with the temperatures themselves; *r tan.* 1 being fixed to prevent burning of cylinder oils and packing, and *r tan.* 2 by the cold well temperature.
9. Work is lost in (*a*) the "solid" friction of the engine parts, (*b*) the fluid friction of the passing steam.

A chapter on Hydraulics and Hydraulic Machinery and a good index completes the book, which can be highly commended, with the reservation that the young student and apprentice without an instructor will probably often be puzzled to comprehend the condensed and somewhat inadequate explanations.

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Theory and Construction of a Rational Heat Motor. By Rudolf Diesel. Translated by Bryan Donkin, M. Inst. C.E. London: E. & F. N. Spon; New York: Spon & Chamberlain.

The author of this little book of 85 pages is the inventor of a heat motor which promises to be to the gas engine what Watt's steam engine was to the atmospheric engine.

The fundamental invention of Watt consisted in the addition of a separate condenser, thereby avoiding the enormous waste of heat occasioned by the alternate heating and cooling of the cylinder which occurred in the atmospheric engine. Mr. Diesel's invention does away with the water-jacket that carries away from a third to a half of the heat generated in the cylinder of an internal combustion engine.

The method and the efficacy of Mr. Diesel's invention can be best shown after the consideration of the action of a gas engine like the Otto engine. This engine draws in an explosive mixture of air and gas during the filling stroke, and on the return stroke compresses it to about 50 lbs. above the atmosphere. The charge is then ignited and explodes nearly instantaneously, and the pressure rises rapidly to about 200 lbs. above the atmosphere, and the temperature becomes about 1,600° C. The piston then makes the motor stroke, and the gas expands to about 20 lbs. above the atmosphere at release. Owing to the phenomenon known as after-burning, the gas remains at a high temperature throughout the expansion, and flame often flashes into the exhaust-pipe. Water is circulated through the water-jacket to prevent the temperature of the cylinder walls from rising too high. The expansion curve very nearly coincides with the adiabatic line for a perfect gas, which shows that the heat carried away by the water-jacket is nearly the same as that generated by the after-burning.

Let us consider that form of Mr. Diesel's motor which most nearly resembles the Otto engine. It is interesting to know that an engine of this type, to indicate 15 H.P. at 300 revolutions per minute, is now undergoing test in Germany. This engine draws in atmospheric air and compresses it to 90 atmospheres then by raising the temperature from 20° to 800° C., which corresponds to a red heat. The pressure of 90 atmospheres is, roughly, 1,300 lbs. above the atmosphere, a pressure seven or eight times as high as that commonly used with steam engines. The high pressures required for the proper action of Mr. Diesel's motors will probably give trouble in the development for commercial purposes; but as the pressures are developed gradually, and do not occasion shocks, he thinks that they will present no insuperable obstacle. Fuel in a finely divided state is fed into the cylinder during about one-tenth of the motor stroke, and burns instantly in the hot air. The admission should be so regulated that the temperature shall remain at 800° C., making this part of the expansion line an isothermal. The method of regulating the supply of fuel will probably be worked out experimentally; at any rate, the details are not clearly explained in the book. After the admission of fuel ceases the expansion is nearly adiabatic, and gives at the end of the stroke a pressure of about 9 lbs. above the atmosphere and a temperature of 187° C.

The theoretical efficiency of this cycle is 65.4 per cent, which corresponds to something more than a quarter of a pound of coal per H.P. per hour. If we add half again as much to allow for imperfections, we shall have $\frac{4}{10}$ lb. per H.P. per hour—a sufficiently brilliant result.

A more complete and also a more complicated form of motor, which will be referred to later, has an efficiency of 73 per cent., which corresponds to just ¼ lb. of coal per H.P. per hour. This is considered to be ten times the efficiency of the best steam engine, so that the author hopes for five or six times as good results as one obtained by steam engines. But steam engines have shown an actual efficiency of 18 or 19 per cent., using about 1¼ lbs. of coal an hour. But an inventor who can reduce coal consumption to one-third will have abundant success and fame.

Mr. Diesel finds that by closing the admission-valve at three-fourths of the filling stroke, and allowing an idle expansion to the end of the stroke, and so starting the compression from the atmospheric pressure at one-fourth of the return stroke, he can carry the expansion during the motor stroke down to the atmospheric pressure. The gain in efficiency by this device is only 2.4 per cent., and is properly considered not worth while.

Mr. Diesel has also worked out a cycle, and has devised the mechanism for an engine to give a theoretical efficiency equal to that of Carnot's cycle. His mechanism uses two single-acting pistons, or rather plungers, and a larger double-acting piston, which acts as an air-compressor on one side and an expander on the other side. The mechanical arrangements are not complicated, and seem to have been carefully worked out. An intelligible description is, however, beyond the limits of a review. It may, however, be interesting to note some of the main features. They involve an isothermal compression to nearly three atmospheres by the aid of water injected into the air compressor; while an isothermal compression cannot be attained by this means, the air can unquestionably be brought to the temperature of the atmosphere after compression. Then there is an adiabatic compression to 800° C. and to 250 atmospheres, which is, roughly, 3,600 lbs. above the atmosphere, a pressure which it may be hard to obtain in an engine, and harder yet to use. This compression takes place above one of the plungers, which on the next down stroke provides for the isothermal expansion, during which fuel is admitted, and for an adiabatic expansion to four or five atmospheres. The air is then transposed to the top of the large cylinder and expanded down to atmospheric pressure. The two plungers which rise and fall together make one motor stroke out of four, while the expander acts on each down stroke and serves for completing the expansion for both plungers.

The valve mechanism involves the use of cams making 150 revolutions per minute, which may lead to practical trouble or annoyance. The inventor also introduces helical gears where modern-cut bevel gears would probably do better.

A very complete series of mechanisms are arranged for feeding fuel in various states—solid, liquid, and gaseous—but the regulation of the supply during admission does not appear to be shown by the book, as has already been said. There can be no difficulty in the use of gas introduced in fine streams into hot air. Liquid fuel, like petroleum, which is used in the experimental engine, can cause little trouble unless the flame may deposit carbon on the walls of the cylinder. The inventor naturally desires to use solid fuel, as being the cheapest. He shows how finely powdered coal may be introduced at the proper time. As only a small quantity of coal is introduced at a time, and as the ash remaining after combustion will be but a fraction of the coal, he concludes that it will be swept away by the air, and will make no trouble. He, however, suggests that the coal may be crudely burned to gas if necessary. He does not, however, seem to consider the difficulty of compressing this gas, already at a high temperature, without first cooling it.

To make a brief review intelligible, we have begun with the description of his engine, which forms the second chapter of the book, and have considered first his crudest form of engine, which he describes last of all. In a manner we have worked backward through the second half of the book.

The first chapter takes up the thermodynamic theory of internal combustion engines of several types, including engines in which the combustion is at constant pressure, as in the Brayton engine, engines in which the combustion is at constant volume, as in the Otto engine, and finally his own type of engine, in which the combustion is at constant temperature. This work is thorough and logical—too much so, perhaps, as it appears to run into unnecessary refinement and tedious details. And yet, as only the theory of perfect gases is used, it is neither long nor difficult.

The author shows that the application of a regenerator to an internal combustion engine is undesirable. He assumes that it is used to heat the charge of air drawn in during the filling stroke of the compressor, which is truly the only place where it can be used; he appears to conclude that the principle of the regenerator is wrong instead of recognizing that it cannot be applied at the right part of the cycle with three engines. A correct statement of the effect of heating the charge is given by Mr. Dugald Clark in his work, "The Gas Engine," published in 1886. There can be no question in the mind of any one who is familiar with the action of closed cycle hot-air engines, like the Stirling engine, that a regenerator is required if any amount of power is desired, not to say anything about efficiency; and it is for these engines that the theory of the regenerator is discussed by Rankine and Zeuner.

The translation by Mr. Bryan Donkin is admirable. He is to be congratulated that in a work of this sort the typographical errors are so few and so unimportant.

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ON THE DEVELOPMENT AND TRANSMISSION OF POWER FROM GENERAL STATIONS. By William Cawthorne Unwin. London and New York: Longmans, Green & Co. 312 pp., 5¼ × 8¾ in.

This treatise, the author says, is based on a course of lectures delivered at the Society of Arts in 1893. Their general construction in a measure indicates this, as the different chapters are made up into convenient lengths for lectures, and have a sort of class-room flavor which it would be difficult to describe with precision, but is easily recognizable. It results, probably, from the fact that few authors who intend to deliver orally what they write can divest themselves entirely of a consciousness of that purpose, and so their writing in some way shapes itself into that final form or style. Of course this has little or nothing to do with the intrinsic value of the lectures or of the book. This is determined by other considerations.

The titles of the chapters will indicate the subjects treated better perhaps than anything else which can be said. These are: I, The Conditions in which a System of Distribution of Energy is Required, and General Considerations on the Sources of Energy; II, Power Generated by Steam Engines, Conditions of Economy, and Waste; III, The Cost of Steam Power; IV, The Storage of Energy; V, Water Power; VI, Hydraulic Motors; VII, Telodynamic Transmission; VIII, Hydraulic Transmission; IX, Transmission of Power by Compressed Air; X, Calculation of a Compressed Air Transmission when the Subsidiary Losses of Energy are Taken into Account; XI, Distribution of Power by Steam; XII, Distribution of Gas for Power Purposes; XIII, Electrical Transmission of Power; XIV, Examples of Power Transmission by Electrical Methods; XV, The Utilization of Niagara Falls.

In the opening chapter the author says: "The special problems to be dealt with are the conditions which favor the production of a convenient form of energy on a large scale and in the most economical way; the means of conveying it to a distance and distributing it to consumers; the arrangements for measuring the quantity delivered; and lastly, the relative advantages and disadvantages of a system in which the energy is obtained on a large scale and distributed to many consumers, compared with a system in which each consumer produces the power he requires in his own locality and under his own supervision and responsibility."

In the chapter on Steam Engines, the fact that small engines are costly, uneconomical and inconvenient, and also that when the load of large engines is varying and intermittent, the conditions are not favorable to economy, is stated, and in what follows the cases are examined in detail and the causes of waste are traced to their source.

From a table of carefully selected steam engine trials the following conclusions are drawn:

"The steam consumption and fuel consumption are less for large engines than for small engines; less for quick than for slow engines; and for suitable pressures, less for compound and triple than for simple engines. Two special groups of tests have been selected to show the economy due to jacketing and the economy due to the use of superheated steam." With reference to the latter, the author says: "Lately superheating has been re-introduced in Alsace, where its advantages were first discovered, and superheaters have been applied to a large number of boilers. Many experiments have been made by Alsatian engineers with saturated and superheated steam in the same engines. In all cases they have found an economy ranging from 10 to 25 per cent. when superheated steam was used. It has been commonly alleged that the high temperature of superheated steam causes scoring or erosion of the cylinder and valve faces. Such injury did occur in the early use of superheated steam, for at that time no lubricant was obtainable capable of standing a high temperature. But this danger has probably been very greatly exaggerated. The cooling action of the cylinder is so great that superheated steam does not retain its high temperature for a sensible time after admission. With ordinary care and the use of a good lubricant it does not appear that the engines using superheated steam suffer any injury." In some experiments which the au-

thor made to test the relative economy of an engine working with saturated and superheated steam, he found an economy of 17.6 and 20.1 per cent. from the use of the latter. On another page we give an engraving and description of a boiler for producing superheated steam, and which has shown some remarkable economies.

The general plan upon which the book is constructed is to describe methods of distributing power, then give a succinct explanation of the theory on which they act, and a general statement of the cost and conditions under which they can advantageously be used. The description of various "installations" for the distribution of power by various systems is admirable; and nowhere else can an engineer learn so easily what has been done in actually using the various systems as he can from the book before us.

The author is loud in his praises of the advantages of distributing power by compressed air. Of the use of this method in towns, he says it has the following desiderata:

"1. The possibility of indefinitely subdividing the power distributed and measuring the supply to each consumer.

"2. Minimum first cost of distributing mains and minimum loss of energy in distribution.

"3. Simplicity, cheapness, and efficiency of the motors required by consumers of power, and especially that the motors should require little attendance and involve little risk.

"4. Freedom from danger to life or property when accidents occur to motors or distributing mains.

"5. Facility of adaptation to various requirements additional to the supply of motive power.

"The air motors are generally of a very simple kind, and are very convenient. They can be started at any moment; they are free from inconvenience, from leakage, heat or smell, and they require a minimum of attendance. Often the exhaust can be used to cool and ventilate the working rooms. The air motors are used for various purposes. At some of the theatres and restaurants they drive dynamos for electric lighting. At some of the newspaper offices there are motors of 50 and 100 H.P., driving printing machines. In workshops there are motors driving lathes, saws, polishing, grinding, sewing, and other machines. At the Bourse de Commerce the compressed air drives dynamos for electric lighting, and also is used to produce cold in large refrigerating stores. In many of the restaurants air is used for cooling purposes. It is also used to work cranes and lifts directly, a water cushion being used between the working cylinder and the lift."

Probably many readers of this book will be as much struck with the low estimate of the value which the author seems to place on the system of electrical transmission of power as they are with the high valuation with which he regards pneumatic transmission.

Of the former system he says: "Having regard only to plants actually at work, it must be confessed that the total amount of power transmitted electrically and used for industrial purposes, exclusive of traction, is not yet very great. . . . If electrical transmission is to be extensively used, it must be when it can be carried out so cheaply that power can be supplied at a less cost than that at which consumers can produce it for themselves. . . . The ordinary price of electricity for lighting purposes is 6 *d.* per unit, which is equivalent to about £60 per H.P. per year of 3,000 hours. At that price it can only be used for power purposes either when the power is required for short periods intermittently or where there is great local inconvenience in employing steam or gas engines. It is only where electricity costs from one-sixth to one-tenth of its ordinary price when used for lighting that it can have any large importance as a means of obtaining power."

He then concludes that systems for distributing motive power electrically have the following limitations:

"(*a*) When the power is initially steam power, its distribution electrically adds so much to its cost as to prohibit its transmission to any great distance in nearly all cases.

"(*b*) Hitherto it has only been in districts where cheap overhead conductors carrying high-pressure currents can be safely used that electrical methods of transmission have proved commercially successful."

In the chapter on the Storage of Energy, a brief description is given of the system of thermal storage proposed by Mr. Druitt Halpine. His plan is to communicate heat to water in boilers, and then store the water thus heated to a high temperature in tanks or reservoirs, which are of course properly protected from a loss of heat from radiation. From the reservoirs steam is taken through a pressure-reducing valve exactly when and in what quantity it is required. Very favorable reports of this system have been made, and it seems to be gaining in favor very rapidly in Europe, where it is now in use. It would have added very much to the interest of Mr. Unwin's book if he had given a fuller description of this system. But without this the book is a very valuable contribution to the branch of engineering science to which it relates, and it occupies a place which no other treatise does.

## BOOKS RECEIVED.

Memoranda Regarding Rapid Transit Routes. By J. J. R. Croes.

The Aeronautical Annual, 1895. Edited by James Means. Boston: W. B. Clarke & Co.

The Steel Construction of Buildings. By C. T. Purdy, C.E., Bulletin of the University of Wisconsin.

Practice and Theory of the Injector. By Strickland L. Kneass, C.E. New York: John Wiley & Sons.

The Evolution of a Switchboard. By Arthur Vaughan Abbott, C.E., Bulletin of the University of Wisconsin.

Notes on the Year's Naval Progress. Navy Department, Office of Naval Intelligence. Washington: Government Printing Office.

Proceedings of the International Electrical Congress. Held in the city of Chicago, August 21-25, 1893. New York: Published by the American Institute of Electrical Engineers.

Practical Application of the Indicator, with Reference to the adjustment of Valve-gear on all Styles of Engines. By Lewis M. Ellison. Published by the Author, 25 Lake Street, Chicago.

## TRADE CATALOGUES.

Graphite as a Lubricant, Scientifically and Practically Considered; also its Value as an Accessory for Engineers and Machinists. Third edition, revised. Joseph Dixon Crucible Company, Jersey City, N. J. 20 pp., $5\frac{1}{4} \times 6\frac{3}{4}$ in.

This is a new edition of a publication already noticed in our columns. It tells all about "Graphite as a Lubricant," with reports and testimonials as to its value for that purpose.

The Venturi Metre. Builders' Iron Foundry, Providence, R. I.

This company have issued a new edition of a pamphlet describing this ingenious machine, which is patented by Mr. Clemens Herschel, and is manufactured by the Builders' Iron Foundry. In this new pamphlet the construction of the metre is described more fully, and different applications of it are described which add to the interest of the publication.

Catalogue of Machine Tools, made by the Cady Manufacturing Company, Cleveland, O. 24 pp., $3\frac{3}{4} \times 6\frac{1}{4}$ in.

The class of tools which this Company manufacture are drop-hammers, power presses of various kinds, punches and shears combined, automatic, rotary and semi-automatic wire straighteners and cutters, and other wire-working and sheet-metal machinery, and also portable forges, emery grinders, drilling machines and screw presses. Many of them are illustrated by good wood-engravings with brief descriptions.

Catalogue "M," Bundy Radiators for Steam and Hot Water, also Heating Specialties Manufactured Exclusively by A. A. Griffing Iron Company. New York. 176 pp., $8\frac{1}{4} \times 5\frac{1}{4}$ in.

This book contains what its title indicates—that is, illustrations of heating apparatus, among them a number of new features, but which are hardly included within our specialty of mechanical engineering. The book is for steam-fitters, engineers, architects, and dealers in that kind of "goods."

Calendars.

Of these reminders of one's mortality we have received a number. One from the Buffalo Metre Company illustrates the meter which they make, and which measures water and not time. The card on which the calendar is mounted also has an engraving showing a bird's-eye view of Niagara Falls and a sectional view of the power tunnel. The Lawrence Cement Company, of New York, have sent us another calendar with a very effective engraving of a lion, we suppose to symbollize the strength of their cement. It does not seem quite sure that the lion is in this case the correct emblem—lions are strong to rend asunder, not to hold together. A gigantic leech, a life-insurance agent, or a poor relation have more capacity for holding on than a lion has. The New York Dredging Company also remind us of the flight of time by a calendar on which they have illustrated one of their dredges discharging through 5,700 ft. of pipe. *Tempus fugit.*

ILLUSTRATED CATALOGUE, No. 19, OF STEAM PUMPING MACHINERY, Manufactured by Dean Brothers' Steam Pump Works, Indianapolis, Ind. 134 pp., 6 × 7½ in.

Messrs. Dean Brothers have here availed themselves of all the most recent modern means of publishing a book of this kind in the way of good paper, typography and engraving. The frontispiece is a view of their extensive new works, which have recently been occupied, and on the opposite page is an excellent interior view of their machine shop. Following this is a sort of sectional diagrammatic view of one of the Dean pumps, showing the construction and peculiarities of its valve gear. A very good description of it is given on the opposite page. After this an excellent view of a boiler-feeder, followed by directions "how to order pumps," which ends with the injunction, "Be sure to order a pump large enough for the service intended. Many make the mistake of ordering pumps too small. A slow piston speed is desirable, especially when pumping against heavy pressure."

The illustrations which succeed this are most of them very good half-tone engravings, representing pumps which might be used for pumping any conceivable liquid, from earth oil to the nectar of the gods. There are boiler-feeders, tanks, double plunger, fire, low-pressure, ball-valve, vertical, upright, deep-well and mine, sinking, brewers', air, duplex fly-wheel, distillery, rectifiers', power, geared, natural-gas, pneumatic lift, air compressor, crank, fly-wheel, artesian well, vacuum, and air pumps, with condensers, ammonia and duplex pumps of various kinds. The book ends with directions for setting up and running pumps, hints on hydraulics, boiler supply, a table to show the equivalent pressure due to columns of water from 10 to 400 ft. in height. Also the number of gallons of water delivered and the height to which it will be projected through nozzles from ½ in. to 2 in. diameter, a table showing the capacity of pumps at 100 ft. of piston speed and another showing the strokes required to reach a piston speed of 100 ft. per minute. A table of areas of circles, and another giving the percentage of saving of fuel by heating feed water with steam at 60 lbs. This latter is interesting, and is reproduced here. It is well worth study by steam users:

coated paper, luxurious printing and binding, it is difficult to find words which will adequately describe some of the publications of this kind which are now being issued. The one before us is an example. We must begin, however, with a little animadversion. The lithographed title-page is hardly up to the standard and style of the rest of the book.

The first illustrations after the title-page are two interior views of the director's car, *The Nomad*, for the Rio Grande Western. These views—and nearly all the other engravings—are half-tone engravings, made from excellent photographs, and those referred to represent an elegant interior. An outside view of the car, which is 65 ft. long over the body, is given on the following page, and is also an admirable illustration. A view of a six-wheeled truck and a telescope-plate comes next. There is no printed description of any kind in the book, the engravings being printed on one side of the leaves only. Some explanation of the uses of "the telescope-plate" would be desirable.

There are also some admirable views of the interior and also of the exterior, and a plan of a "*café* car" for the Wabash Railroad. We must retract, though, about the plan—*it* is not admirable, but must have been made by some 'prentice draftsman, and as a specimen of the draftsman's art is bad, as are the other similar plans in the book. Views, both interior and exterior, of a parlor car, also for the Wabash Road, follow, which are excellent. Then we have interior views of a chair car for the Missouri Pacific Road, without the chairs—that is, the photographs were made before the chairs were put in. An exterior view (good) and a plan (bad) follow. Similar views of a Pacific Road coach are also given. Without enumerating the roads for which they were built, it may be said that there are views of a passenger and baggage, a baggage, mail and express, a mail and a baggage and an express car. Some excellent views are also given showing the system of framing which the Company uses for passenger cars. These represent it as seen from the outside and inside before the framing was covered. There are also views of "museum cars" and an advertising car, which incline one to smile. Views from photographs of excursion, street, motor, electric,

PERCENTAGE OF SAVING OF FUEL BY HEATING FEED WATER (STEAM AT 60 LBS.)

| FINAL TEMPERATURE. | INITIAL TEMPERATURE OF WATER. | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32° | 40° | 50° | 60° | 70° | 80° | 90° | 100° | 120° | 140° | 160° | 180° |
| 60° | 2.39 | 1.71 | 0.86 | ... | | .... | .... | .... | .... | .... | .... | .... |
| 80° | 4.09 | 3.43 | 2.59 | 1.74 | 0.88 | ... | .... | .... | .... | .... | .... | .... |
| 100° | 5.79 | 5.14 | 4.32 | 3.49 | 2.64 | 1.77 | 0.90 | .... | .... | .... | .... | .... |
| 120° | 7 50 | 6.85 | 6.04 | 5.23 | 4.40 | 3.55 | 2.68 | 1.80 | .... | .... | .... | .... |
| 140° | 9.20 | 8.57 | 7.77 | 6.97 | 6.15 | 5.32 | 4.47 | 3.61 | 1.84 | . | .... | .... |
| 160° | 10.90 | 10.28 | 9.50 | 8.72 | 7.91 | 7.09 | 6.26 | 5.42 | 3.67 | 1.87 | .... | .... |
| 180° | 12.60 | 12.00 | 11.23 | 10.46 | 9.68 | 8.87 | 8.06 | 7 23 | 5.52 | 3.75 | 1.91 | .... |
| 200° | 14.30 | 13.71 | 13.00 | 12.20 | 11.43 | 10.65 | 9.85 | 9.03 | 7.36 | 5.62 | 3.82 | 1.96 |
| 220° | 16 00 | 15.42 | 14.70 | 14.00 | 13.19 | 12.33 | 11.64 | 10.84 | 9.20 | 7.50 | 5.73 | 3.93 |
| 240° | 17.79 | 17.13 | 16.42 | 15.69 | 14.96 | 14.20 | 13.43 | 12.65 | 11.05 | 9.37 | 7.64 | 5.90 |
| 260° | 19.40 | 18.85 | 18.15 | 17.44 | 16.71 | 15.07 | 15.22 | 14.45 | 11.88 | 11.24 | 9.56 | 7.86 |

STOW MANUFACTURING COMPANY, Inventors and Manufacturers of the Stow Flexible Shaft, Binghamton, N. Y. 32 pp., 6 × 8¾ in.

The Stow flexible shaft is so well known by all mechanical engineers and the victims of dentists' chairs that it requires no description. The company which are the chief manufacturers of it have issued a new catalogue (No. 5), showing not only the well-known appliances, but some new ones. Besides the shafts themselves and their immediate connections, this company also makes what may be called collateral tools and appliances which are used in connection with the flexible shafts. These include breast drills, portable screw feed drill presses, pedestal drills, universal joints (for the shafts), drill rests and supports, tapping and reaming machines, ring grinders, counter shafts, lathe centre grinders, portable emery grinders (operated by flexible shafts), stop clutches, which permit the working tool to be stopped and started at will without stopping the motion of the shaft itself, combined flexible shaft and electrical motor, radial flexible drilling, stone grinding and polishing, and boring machines, transfer pulleys, etc.

The company reports that "the last few months have shown a steady, healthy growth, and they expect to do a very satisfactory business in 1895."

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CATALOGUE OF ST. CHARLES CAR COMPANY, St. Charles, Mo. 112 pp., 10 × 13¼ in.

In reviewing trade catalogues, a reviewer is apt to run out of superlatives. What with photography, half-tone engravings, refrigerator, caboose, box, stock, flat, coal, dump, drop-bottom, hand, push, logging, side-dump and furniture cars fill the remainder of the book. The illustrations are, some of them, of superlative excellence, and excepting the plans are all good. They are printed on heavy coated paper, and are all well printed.

There is only one serious fault to be found with the book: it has cost so much that the St. Charles Company have felt obliged to discontinue their advertisement, temporarily, in this and other papers. All that is left us is the hope that orders and profits will come to the Company like a flood, and that the newspapers will then get a share of the latter.

## NOTES AND NEWS.

**An Automatic Steersman.**—An automatic helmsman, or application of electricity to the direction of the course of a vessel, is described in a French electrical journal. It is to be operated by an attachment to the compass. The errors in manual steering are stated to be seldom less than 1° or 2°, corresponding with an error of nearly 12 miles laterally in a day's sailing. With the automatic method greater accuracy is said to be possible. The standard compass is used, and a current from a Ruhmkorff coil is passed from the pivot of the needle to the north pole extremity, whence sparks of three millimeters length pass to one of two semicircular pieces of aluminum, insulated from each other, the gap between them being set to the desired sailing direction. When the spark passes to one of these the

current, by means of a relay, starts a motor in one direction, which in turn operates the rudder, while if the spark passes to the other piece, it moves the rudder in the other direction. The apparatus has been in use for two months on a steamer, and it operated very successfully. An additional device is mentioned in which the record is automatically kept.

**Preservation of a Vessel with Crude Oil.**—A singular process is being attempted at Camden, Me., to preserve the wood of a new 1,400-ton schooner, now almost ready for launching for Amos Burdsall, of Toms River, N. J., and some Philadelphia owners. All of the timber on the inside and outside of the vessel has been soaked in crude petroleum to save it from dry rot by exposure to the air and to prevent the ravages of the teredo worm in salt waters. Even the vessel's beams have been coated and the tips of the topmasts. It is expected that the oil will become so thoroughly soaked in the schooner's upper works that the water cannot penetrate through the wood, and thus it will prevent the rotting of the masts and prolong the life of the vessel. This is believed to be the first trial ever made to preserve a wooden vessel in this manner. Old wooden vessels, which have been converted into bulk petroleum carriers after having outlived their usefulness in other trades, have been known to last for years after becoming soaked with either crude or refined oil.

**A New Gun.**—The very heavy cost of modern guns is largely due to the time and labor which are necessarily expended upon the operation of rifling them. The material itself is relatively cheap; and a rifled gun, besides being much more costly, is, other things being equal, more short-lived than a smooth bore. It is almost impossible so to make the gun and the projectile that the soft driving bands of the latter shall, at the moment of discharge, accurately fit into the grooves and lands of the bore, and allow no gases to pass ahead. When these gases do pass ahead of the projectile they score and damage the interior of the gun; and, where the new powders are used and the gases of combustion attain an enormous degree of heat, the process of deterioration, especially in weapons of large calibre, is often very rapid. A Swedish engineer, Mr. W. T. Unge, has devised a method whereby he hopes to save, not only the cost of rifling, but also the interior wear and tear for which rifling is responsible. He proposes to construct all guns as smooth bores, and to fit the projectiles with gas checks which shall render it practically impossible for any gases to rush past them. In order to convey to the projectile an axial rotary motion, such as is at present conveyed to it by the action of the rifling, he has invented a mechanical arrangement which, at the instant of firing, gives to the gun itself an axial rotary motion. This may be either constant or increased. He has satisfied himself that the effect upon the projectile is exactly the same as is produced by the constant or increasing twist of an ordinary rifled gun; and he is of opinion that the adoption of his system, while giving equal or even improved accuracy of fire, will reduce the cost of heavy guns by one-half and add fully 100 per cent. to their endurance.—*The London Times.*

## RÉSUMÉ OF THE ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN FOR THE YEAR 1894.

In our issue for April, 1893, we began the publication of a brief *résumé* of the accidents on the railroads of the United States that resulted in the death or injury to the men on the engine. As we have repeated with each issue, the only or chief source of information which we have is the newspapers, and this information is necessarily inaccurate in many instances, and incomplete when taken as a whole. As we have also said, the publication is made with the "hope that it will in time indicate some of the causes of accidents of this kind and help to lessen the awful amount of suffering due directly and indirectly to them."

In April, 1894, at the end of the first year of the publication of these accidents, we printed a short *résumé* of those that had occurred during the preceding 12 months, and attempted to point out some of the causes that had given rise to them and to roughly locate the responsibility. In taking up the lists that we have published during the 12 months ending with December 31, 1894, which laps back over some of the months included in the last *résumé*, we find that there has been a very decided falling off in the total, but this does not necessarily mean that the average number of accidents per train mile has fallen off, for there is no doubt but that the falling off in the traffic that all the roads of the country have experienced during the past year is responsible for some of the improvement that appears on the surface of the reports. Upon examination we find that during 1894, 134 engineers and 103 firemen were killed, and that 220 engineers and 176 firemen were injured in the 399 accidents that have happened. By referring to the April, 1894, issue of this paper the reader will see that during the preceding 12 months there were 450 accidents, in which 108 engineers and 114 firemen lost their lives, and that 251 engineers and 223 firemen were injured. This means that there has been a falling off of something more than 11 per cent. in the total number of accidents, and that the rate of death and injuries has risen $6\frac{3}{4}$ per cent. and fallen $1\frac{3}{5}$ per cent. respectively; which, being interpreted, may be made to mean that while the total number of accidents have fallen off they have been individually more serious, and that therefore it would appear that the cutting down of expenses and the crippling of the service has resulted not only in increasing the number of accidents per train mile, but has tended to make those accidents that do occur more disastrous than they would have been under normal conditions. We do not wish to be understood as making this as a positive assertion, but merely as putting it forth as a suggestion for one of the reasons of what has occurred. The following is a list of the accidents that we reported for 1894 in which an engineer or fireman was killed or injured:

| | |
|---|---|
| Blowing out of cylinder head | 2 |
| " " " plug | 1 |
| Boarding train in motion | 1 |
| Boiler explosions | 15 |
| Break in two | 1 |
| Broken axle | 1 |
| " connecting-rods | 2 |
| " rails | 5 |
| " side rods | 5 |
| " tires | 1 |
| " trucks | 2 |
| Burned bridges | 1 |
| Bursting arch-pipe | 1 |
| " gauge-glass | 4 |
| Cars blown on track | 2 |
| Cattle on track | 19 |
| Caught between cars | 5 |
| Cave-in | 1 |
| Collisions | 116 |
| Crushed under engine | 1 |
| Cut in cab window | 1 |
| Defective air brake | 1 |
| " bridges | 7 |
| Derailments | 36 |
| Falling from engine | 10 |
| Flying reverse lever | 1 |
| Forest fires | 2 |
| Gas explosion | 1 |
| Jumping from engine | 5 |
| Landslides | 14 |
| Misplaced switches | 27 |
| Obstructions on track | 6 |
| Open drawbridge | 1 |
| Overturning of engine | 1 |
| Rails spreading | 3 |
| Repairing grates | 1 |
| Runaway engines | 1 |
| " trains | 5 |
| Running into hand-car | 2 |
| " off float | 1 |
| Run over | 8 |
| Stone-throwing | 2 |
| Strikers | 6 |
| Struck by ash-pan lever | 1 |
| " " car on siding | 2 |
| " " engine | 2 |
| " " obstruction | 8 |
| " " train | 2 |
| Suffocated by snow | 1 |
| Suicide | 1 |
| Thrown from engine | 2 |
| Train burned | 1 |
| " robbers | 3 |
| " wrecking | 26 |
| Trestle burned | 3 |
| Tubes bursting | 3 |
| Unknown | 11 |
| Washout | 5 |
| Total | 399 |

Referring to this list, we find that collisions are by far the most prolific sources of danger, there having been 116 during the year; next come derailments, at 36; misplaced switches, 27; train-wrecking, 26; cattle on the track, 19; boiler explosions, 15; landslides, 14; and those attributed to unknown causes, 11. If we compare this with the similar list published in March, 1894, we find that the accidents, taken in the order of frequency, stand in nearly the same relations in both instances. At that time they ran: Collisions, falling from engine, misplaced switches, boiler explosions, struck by obstruction, cattle on the track, runaway engine and unknown. From this comparison of nearly two years of observations it would seem that one is warranted in asserting that collisions are by long odds the most fruitful source of railway disasters, and that derailments and misplaced switches are a close second. While train-wrecking has assumed a prominent place in the records of the past year, this danger cannot be said to be a defect in the railway system. One-half of the total cases of train-wrecking of the year occurred during the months of July

and August, at the time of the strike of the American Railway Union, and it is not unreasonable to attribute the epidemic to that as the cause. Such accidents as boiler explosions, landslides and cattle on the track are of about equal importance, and should be attributed to the departments responsible. The mechanical department must father the explosions, the chief engineer the landslides, and the road department the cattle on the track. Not that all of these disasters should be put directly upon the shoulders of the heads of these several departments, but they are supposed to see that the work confided to them is executed with safety and diligence; and while many accidents occur that it would undoubtedly be impossible to avert by any human foresight, it is equally true that many are directly due to carelessness in maintenance, inspection, or construction for which no excuse can be found. Acting on this basis, and taking the accidents as they are recorded, we should place the responsibility as follows:

| | |
|---|---|
| Operating department | 189 |
| Road " | 68 |
| Mechanical " | 44 |
| Personal negligence | 44 |
| Violation of the criminal laws | 37 |
| Unassignable | 17 |
| Total | 399 |

Thus, out of 399 accidents 345 are traceable to the several departments, the mechanical department being responsible for about 12¾ per cent. of the 345, or 11 per cent. of the whole. In reviewing these accidents one year ago, we said that "the predominance of collisions over every other form of accident simply means that suitable provision has not been made for the protection of trains; in short, that the block system is not considered necessary." It would be interesting and somewhat startling, too, we think, if the facts bearing on the accidents of collisions and misplaced switches could be investigated so that the exact ratio due to a lack of suitable signals could be ascertained. Then, if we could obtain the actual cost to the railroad companies of these disasters, there is but very little doubt that a substantial payment could be made on the cost of equipment with interlocking signals had these accidents not occurred. The great trouble in the introduction of the block system is that when an accident does not occur there is no means of presenting an estimate of the saving that might be made in case it had. There is a disposition to consider that as long as the horse has not been stolen there is no danger that he will be. But in reviewing such a mass of matter as that embraced in these reports one is struck, on making the comparison, with the small proportion of minor collisions and derailments that occur on roads that have an interlocking system of signals in use, as compared with those that are not so equipped; and were it not that comparisons are exceedingly odious in some cases, it would be possible to call attention to the marked falling off in the frequency of accidents of this class on certain roads that have put the block system into use.

With the exception of these isolated instances, we regret to be obliged to come to the conclusion that there is no change in the conditions of the safeguards existing on the roads of the United States from that prevailing one year ago. There are about the same number of minor accidents, such as the collapsing of tubes, the bursting of water-glasses, and defective construction in small details; the only improvement that is decidedly apparent is the smaller number of boiler explosions. These have fallen away by nearly one-half; and while this may be attributed to the smaller number of boilers in use, we are disposed to think that the agitation of the subject of boiler inspection by several of the railway clubs during the past season has had something to do with the awakening of the men in charge to the great importance of this branch of the service, and that there is actually an improvement in the condition of affairs. But even though this may be so, there is ample room for further advance; still it must be a matter of congratulation to the mechanical departments that they are responsible for less injury to life and property than either the road or operating departments. One reason for this may lie in the fact that the *personnel* is of a rather higher grade than that employed on the track and on the trains, and a higher standard of discipline can be maintained, but many of the defects of the operating department would probably disappear if it was provided with a better means of handling and controlling the movement of the trains over the road, while the accidents attributable to the road department would fall off if engineers were more particular about the location of signal posts and other obstructions near the line of rails, for there is hardly a month wherein we are not called upon to chronicle the maiming or killing of an engineer or fireman struck by some object placed so near the rails as to strike the man as he leans from the cab window or gangway—a condition for which there is no possible excuse, and which is truly a case of criminal negligence.

## EARLY DAYS OF THE IRON MANUFACTURE.*

By John Fritz.

In deference to a custom long established, by which the president-elect is expected to read a paper on some subject with which he is more or less familiar, I have thought that a brief review of the methods employed in the manufacture of iron, as witnessed by myself, and reaching back to 1838, would interest some of our older members and give our younger ones a glimpse into the trials and difficulties encountered in those early days by the pioneers in this great industry.

In 1840, 12 to 20 tons of pig iron was the make of a furnace per week—at this time from 1,200 to 2,000 gross tons.

In 1840, 3 to 4 tons No. 4 wire rods per turn. They have lately made 176 gross tons in 11 hours.

In 1840 I have not the quantity of puddled iron made; but it was small, as puddling was in its infancy. In 1890, there was made 2,518,174 gross tons.

The earliest rolling-mill statistics are in 1856, in which we produced a total of 498,080 gross tons of all kinds of rolled iron.

In 1840, we produced of pig iron 286,903 gross tons; in 1890, 9,202,703 gross tons, which is more than has been produced by any other nation.

The incidents of which I shall make mention were of such an every-day, practical character that they never have found their way into print.

My first practical experience in iron-making was in 1838, while a cub apprentice in a country machine and blacksmith shop, when I was sent out to a charcoal furnace to do some repair work. The furnace was blown by water power, the motor being an undershot wheel having a wooden shaft, in the ends of which were secured cast-iron winged gudgeons, one of which had a crank cast on it, in which the crank-pin was inserted that drove the connecting-rod and piston in the wooden blowing-tubs, as they were called. The dimensions of the furnace are unknown, but it made about 12 tons of iron per week when it worked well; and when it did not work well, which was often the case, it made none. The particular job I was sent to do was to put in a new blast-pipe connecting the main blast-pipe with the tuyere of the furnace; and when I got it up in place, to my chagrin, I found it did not reach the opening in the stack by about 10 in., the conclusion being that some one had made a big blunder, something that happened sometimes, even in those days; and the supposition was that it must have been the man who made the pipe, as the workmen in those days took their own measurements, and in case of a mistake they generally got what we called a "blowing up," and if the error was made by a cub, he got an especially rough one. While I was thinking the matter over, and wondering if I had better take the pipe back to the shop, several miles away, or move the furnace up to meet it, the man who ran the furnace, or founder, as he was called, came along, and his appearance just at this juncture was not a pleasant one for me, as I expected that when he saw that the pipe did not reach the tuyere he would give me a blast, and a hot one as well. To my surprise, he looked at it for a moment, and said it was just right. But while this let me out, I could not but think it ought to have reached to the tuyere. I afterward learned that the connection was made with a leather pipe called a boot. I still thought they ought to go into the tuyere.

In the neighborhood where I spent my younger days there were several mills for rolling boiler plate, and as a boy I spent much time in watching what at that time was an interesting sight to me. While there were several mills there, the one I propose to speak of was the oldest, and, as it is claimed, the first mill in the United States to roll plates to make boilers, it then having the reputation of making very superior plates, and, I am glad to say, it still sustains its early acquired fame. As a history of this mill reaches back more than fifty years from the time I first knew it, my knowledge of its beginning was obtained from the old people who lived in the neighborhood and from some of the old workmen who had been employed in it, and I hope what they told me will interest you, as it did me to hear it.

In 1790, Isaac Pennock, the great-grandfather of the present proprietors of the Lukens Iron & Steel Company, began the manufacture of iron at a place on Buck Run, Chester County, Pa., called Rokeby, about four miles south of Coatesville. Isaac Pennock was raised as a farmer in the neighborhood, and his parents strongly objected to his going into a business

* Presidential address at the Bridgeport meeting of the American Institute of Mining Engineers.

about which he knew nothing, as they felt he would squander his money. The mill he first built was called the Federal Slitting Mill. In 1810 he bought a saw-mill property on the Brandywine, near Coatesville, which he converted into an iron mill. This mill, which at the time was called the Brandywine, has since developed into the immense plant it now is.

In 1816 Dr. Charles Lukens, a son-in-law of Isaac Pennock, came into possession of the property, and carried on the business of iron-making until his death, which occurred in 1825; and it is claimed that it was between these dates that the first boiler plates were made in this country and in this mill. At the death of Dr. Lukens, his widow, in accordance with his special request, continued to carry on the business, although handicapped by the fact that there were no railroads in those days and the finished iron had to be teamed to Philadelphia, a distance of 36 miles, or to Wilmington, Del., 26 miles, while the coal used was hauled from Columbia, about 35 miles away; yet, in spite of these difficulties, she carried on the iron-making business, hiring a superintendent to look after the works and the workmen, while she herself managed the business of the office. Mrs. Lukens was considered an extraordinary business woman. She built up a business which has been continuously successful up to the present, and which has remained in the same family for four generations; and it was in honor of her extraordinary abilities that the name of the works was changed from Brandywine to Lukens.

Originally the sheets were made from a single charcoal bloom, the bloom having been made in the old-fashioned forge fire, then reheated over an ordinary grate fire and rolled into plates or sheets, which sheets were shipped without being sheared, the shearings in those days being cut into nails. But afterward they put up a reverberatory heating furnace, in which they worked up the scrap themselves. The plate rolls, as near as can now be ascertained, were about 16 to 18 in. in diameter, and from 3 to 4 ft. long in the body, and were driven by an undershot water-wheel. It is said that many a time, when it looked as if the mill would stall, the workmen would rush for the water-wheel, climb upon its rim, and by their united weight help the pass through the rolls, thus preventing a stall, which meant fire cracked rolls, and, later on, broken ones. This water-wheel was afterward supplemented by a breast-wheel so geared as to give more power to the rolls. This enabled them to use larger rolls, but the gearing gave so much trouble that they finally abandoned the use of the water-wheel and put in a steam engine and enlarged their rolls to 21 in. in diameter and 66 in. between the journals. This was again changed to 25 in. in diameter and 84 in. long chilled rolls. After several other changes, they at last put in three high-chilled rolls 34 in. in diameter by 120 in. long, a large Corliss engine to drive them, automatic lifting tables, etc.

The weight and size of the early boiler plates, as made on the oldest mill, I have been unable to get; but it is not supposed that they attempted anything weighing over 500 lbs., and probably 300 lbs. was nearer their limit. As an illustration of the changes that have taken place in this one mill I would say that, as now enlarged, they readily roll plates 119 in. wide and 50 to 60 ft. long. The little old mill, in which the workmen had to climb on the wheel to help make it go round, is one of the best plate mills in the country, and its owners and managers are the great-grandchildren of Isaac Pennock, who in 1790, built the Federal Slitting Mill on Buck Run, and, in 1810, on the banks of the Brandywine, what was called the Brandywine Mill.

In the year 1845 I went to Norristown, Pa., and assisted in the building of what, at that time, was considered the best mill for making bar iron in this country; in fact, it was called a model mill, and in many respects it was so. While it was a geared mill, it was so much better built than any other mill of the kind that it was expected that it would give little or no trouble on that score. But we were sadly disappointed; for, soon after starting, the gears began to give way, the back-lash and the jar of the rolls causing the teeth to break and drop out.

I was given charge of the machinery, and, of course, had to look after the gear-wheels. At times the entire wheels would seem to go to pieces at once; at other times the arms would crack, and then again the teeth would break—each break, of course, stopping the entire mill. Then all hands had to work day and night to get started again. At first we had to go to the foundry to get such parts as had been broken made over. This, of course, caused considerable delay, and to avoid this loss of time we began to keep segments of gearing on hand, and we had separate wrought-iron teeth made ready for insertion, and kept clamps ready to strengthen broken arms. With such extended experience, I became quite an expert in inserting teeth, and it was no doubt due to this fact that on the occasion of several hundreds of my friends coming to Bethlehem not long ago I was arrested at the banquet and tried on the charge of practising dentistry without first having procured a license or diploma!

Soon after the mill started, I was placed in charge of it on the night-turn, including the puddling furnaces and the few heating furnaces used for rolling covers. While this added somewhat to my duties, it proved of great advantage to me, as it gave me an opportunity to obtain a practical knowledge of iron-making. Later on, I was given charge of the mill on the day-turn, which practically meant both day and night, as it was during the day that everything had to be arranged for the night-work before supper could be eaten or rest obtained, and often to the loss of both. In a short time I received, in addition to my other duties, that of having charge of the roll-turning and of seeing that the iron rolled was properly finished. In short, I, who had entered the mill as a machinist, was now in charge as an iron-master; and it was in connection with this new departure that my troubles began.

In those early days the chemistry of iron-making was unknown—at least in this country—and iron-makers were often but the blind leading the blind. At the present time, if there is any trouble with the product of an iron or a steel mill, the chemist is sent for, and he is expected to carefully analyze the ore, fuel, flux, cinder, and even the furnace linings, and find and eliminate the troublesome element, whatever it be, that is damaging the product. But in the early days of iron-making we had no such help, and had to feel our way as best we could.

The process of making bar-iron by the use of the charcoal forge had become too expensive for iron to be used for ordinary purposes, and the art of making bar-iron by the puddling process was the only other means of any promise to which we could turn for relief. Puddling was at that time done by what was called the fermenting process, in which white iron only could be used; and we soon learned that only a few brands of pig iron could thus be worked into merchantable bar-iron, as by reason of being cold short it often proved worthless; and the worst of this was, we did not know what caused it. As the works were built to make high-grade bar-iron, which must be neutral, we were in a great quandary, not knowing which way to turn; but as the only way out was to keep on experimenting, we did so, sometimes finding a pig metal that gave good results. Then all at once it would go wrong again, and why, we could not tell, but it was always in order to lay it on the poor puddler and to give him a good "blowing up."

At times we found that by mixing several brands of charcoal-pig we would get good results; but as the price of bar-iron was low we could not afford to use high-priced pig, and so we began to experiment with anthracite iron—and with the old-time troubles, or even worse, as we got both cold and red-short iron. At this time one of the blast furnaces which had been making charcoal-iron began to use anthracite coal for fuel. In our distress we tried some of their pigs and got quite good results, the bars not being cold-short, but quite inclined to red-shortness, and for many purposes, such as shafting, car axles, heavy bolts, etc., proving very suitable. But for the use of the blacksmiths the iron was quite unfit. They then knew nothing about working red-short iron, and, of course, they condemned it.

We have now learned that good fibrous iron can be made from anthracite pig-metal, but for the highest grades of bar-iron we were still compelled to use charcoal-pig, and in the old way. It would occupy too much of your time to relate in detail the long series of experiments, often ending in disaster, we went through, never knowing when the iron would be good or what it was that made it red, until at last, by accident, we stumbled on the cause of the trouble.

We noticed that when, after making red short iron for a time, a change was made to neutral iron, the iron was still inclined to red-shortness. In a day or two the red-shortness would die out, and we would get on to good bar iron; and it gradually dawned on us that the trouble might come from the cinder that was left in the furnace when red-short iron was being made. So when we next changed over from red-short to neutral iron we cleaned all the cinder out of the furnace with great care, and refixed it with neutral cinder, and to our great joy found that the secret of our troubles had been discovered, and that we could now make neutral or red-short iron as we wanted to, with a tolerable degree of certainty.

While the experiences and trouble gone through were both perplexing and annoying, they proved of great value to me in after years, and especially when we began to make steel by the Bessemer process; for I had early learned how a very small percentage of an objectionable element, either in the ore, the metal, or the fuel, would greatly damage the product. In addition to the trouble we were having in making the iron, we were constantly breaking gearing, spindles, or rolls and couplings. In order to reduce the cost of repairs as much as

possible, we tried to have some part of the train made strong enough to do the work when everything was going right, and weak enough to break when anything was going wrong. This was, of course, a cut-and-try business; sometimes the part we intended to break would be made of extra strong iron, and then it would fail to break and some other part would give way; then we would reduce the pattern and make it lighter, and the next casting made of that pattern might happen to be weak iron, and it would break too easily, and then we would have to strengthen the pattern again; and so from day to day we went on, with one break after another, varied occasionally by the giving way of a coupling-box, spindle or breaking-box. The latter would let the end of the roll rise up in the housings, and if the roll was a collared one, off would go the collar, and the roll would be ruined. Of course, the breaking of teeth in the gear-wheels was a common occurrence; and so much trouble came from this source that I remember that, over 45 years ago, I was almost inclined to register a vow that I would never again have anything to do with a piece of machinery that had a cog-wheel in it.

In the year 1854 David Reeves, together with a few of his friends, leased a works for making iron rails, located at Johnstown, Pa. I was sent there to complete the mill and to superintend its working. As it was at this place where afterward great and important changes in the manufacture of rails were introduced, I have thought that a brief history of the works would be of some interest to the members of the Society.

The works were originally commenced by an organization called the Cambria Iron Company, but after the mill was partially built their money gave out, and the project was considered a failure. It was at this time that David Reeves, Matthew Newkirk, George Trotter, and a few others, joined together and leased the plant as it stood; Mr. Reeves, Mr. Trotter and Mr. Newkirk being the most prominent in the matter, and Mr. Newkirk acting as the business manager.

Mr. Newkirk then gave me instructions to go to work at once and complete the mill as soon as possible. Having previously examined the works with great care, I can assure you that it was with serious misgivings that I undertook the task. There was a vast amount of new work to be supplied, and I had very serious doubts as to the efficiency of what had previously been done. From what I learned as to the kind of pig-iron that was to be used, the outlook was anything but encouraging, and I came to the conclusion that there was serious trouble in store for me when the mill would be ready to start; and I can now testify that my forebodings were fully verified later on.

When we at last got to work and rolled a few rails, the edges of their flanges looked like saw-teeth, and the head was rough and full of small holes, and everybody about the mill, from the owners to the water-boy, was disgusted and sick. This was especially true concerning the heaters and the men about the rolls, for they were paid by the ton of finished rails. It was the general conclusion that something would have to be done, and right quickly, too. There were three charcoal blast-furnaces that belonged to the company, one of which happened to be in blast at the time, so we got some charcoal-pig and puddled it and rolled it into covers for the bottoms of the rails, the common iron being above them. These piles were rolled so as to put the charcoal-iron on the edges of the flanges. This worked pretty well as far as the flanges went, but it did not cure the trouble with the heads; so we had to roll other covers for the tops of the piles, to make the head of the rail good; and with hot and cold patching, and a liberal use of putty, we managed to get some rails that passed muster. By continually experimenting in the piling of the iron, and changing mixtures, we finally got out some fairly good rails; but the engine and fly-wheel driving the train were of such a construction that it was not safe to run it over fifty revolutions per minute, which was too slow to make rails out of the materials we were using.

One of the most serious troubles was that the forward end of the pile would split open in the rolls, so that, when we came to enter it in the next pass, it refused to go in, and much time was lost in bunting it in the buggy, consequently cooling the pile to such an extent that when the rolls did get hold of it, spindles, coupling-boxes, and sometimes the rolls themselves, would break, causing both expense and delay, which, in connection with the general depression in business, led to troubles that brought the enterprise to an end.

Again a new company was formed, and it was known as Wood, Morrell & Company. It was in part made up by David Reeves, Charles Wood, Matthew Newkirk, George Trotter, D. J. Morrell, John Shoenberger, and E. Y. Townsend. Mr. Charles Wood was made President, E. Y. Townsend, Vice-President, and D. J. Morrell, General Manager. The change in the organization of the company did not, however, change the troubles in the manufacture of the rails nor increase the output, both exceedingly important matters, which, unless they could be greatly improved, would still leave the handwriting of failure on the wall. Having, in view of the past, and remembering my former doubts, gone over the entire subject again, I made up my mind as to what must be done to make a success; and I was prepared to submit my plans and recommendations to the new company.

My plan was to build an entirely new train of rolls, and to make them three-high and 20 in. in diameter. This involved a new engine with a fly-wheel that could be run at 100 revolutions should it be desirable to do so. In fact, it practically meant an entirely new rail-mill. When the plan was submitted to the company they said at once it could not be done, for the reason that the expense would be too great; and besides, the mill they had was an entirely new mill, which was supposed to be the very best in the country, and they did not see why it could not be made to do good work. Finally, I succeeded in convincing some of the managers that something must be done, and that if they would adopt my recommendations I was certain of success. After consulting together, they directed me to go on and build an 18-in. two-high geared train to take the place of the train we had. To this I replied in the most emphatic manner that I would not do it, as it would be money thrown away. To my refusal, they said the position taken was a most arbitrary one, and one I had no right to take, as I was in their employ on a salary to manage their works, and that they had some right to say what should be done. To this I assented partially, but at the same time told them that if they continued in the line they were in there would in a short time be held a large funeral, and I did not intend to stay and attend it. At this the meeting adjourned.

In a few days they gave me permission to go on and build such a mill as I wanted, but they thought it would be better to make the rolls 18 in. instead of 20 in. in diameter; and, by way of compromise, I consented (which was a mistake), and began to build the new train and make other important changes about the mill.

About the time we had the patterns for the new train and engine completed we were brought to a stop by a protest in the form of a legal document, holding the managing partners personally responsible for the building of a new mill. This, of course, was an unexpected stunner, and all work was suspended.

One Sunday morning, when, as I now realize, I ought to have been at church, Mr. Townsend came down to the mill, where I was alone, and brought with him the legal protest and read it to me. After all these years, no person other than myself can fully appreciate the trying position the managers were in. On the one hand, I was urging them to go on and build a mill on an untried plan, and absolutely refusing to build the two-high geared mill they asked for, feeling that such a mill would only in a small way mitigate the troubles we had gone through, and that the money spent on such a plant would be thrown away. On the other hand, there was a strong party of stockholders protesting in the most positive manner against going on with my plans, and notifying the managers that they would hold them personally liable for all the loss and damage that might grow out of their unwise action, as they considered this action to be, in adopting a new and untried method that was against all practice in this and the old country, from which at that time we obtained our most experienced iron-makers. Besides, prominent iron-makers in various parts of the country had said to Mr. Morrell that the whole business would end in a failure, and that man Fritz would ruin them. The heaters and rollers were also opposed to my plans, and they appointed a committee to wait on the managers and to say to them that the three-high train would never work; that they themselves would suffer by reason of its adoption, but that if the managers would put in a two-high geared train, which was the proper thing to do, the mill would go all right.

As I look back to that eventful Sunday morning long years ago, when, sitting on a pile of discarded rails, with evidences of failure on every side, Mr. Townsend and myself quietly and seriously talked over the history of the past, the difficulties of the present, and the uncertainties of the future, I cannot but feel, in view of what has since come to pass, that it was not only a critical epoch in the history of the Cambria Iron Company, but as well the turning-point in my own life. For, as Mr. Townsend rose to leave, after a long conference, he turned to me and said: "Fritz, go ahead and build the mill as you want it." I asked: "Do you say so officially?" To which he replied: "I will make it official." And he did so.

I want to avail myself of this opportunity to say that to no other person so deservedly belongs the credit, not only of the introduction there of the three-high roll train, but of the subsequent wonderful prosperity that came to the Cambria Iron

Company, as it does to E. Y. Townsend, then its Vice-President. Nothwithstanding I had now the consent of the company to go on, many of my warmest friends, some of whom were practical iron-workers, came to me and urged me not to try so foolish an experiment. They said I had taken a wrong position in refusing to build the kind of a mill the company wanted; that in all probability the mill I was getting up would prove a failure, and, being a young man, my reputation would be ruined for life. To this I replied that possibly they were right in what they said, but that I had given the subject the most careful consideration, and was ready to take my chances on the result. The work was now pushed on as fast as possible. In the construction of the rail-train I made a radical departure from the old practice, which was to provide breaking pieces here and there. I tried to make everything so strong that nothing would break. One of the previous methods was to make coupling-boxes and spindles so that they would break when any extra strain would come on them, and the leading spindle had a groove cut around it so that it would be sure to break before the rolls. The result was the constant breaking of some of these safety devices. In addition to all these devices there was what was called a breaking-box on top of the rolls which held the roll in position, which was made hollow, so as to crush if the strain was too great. I directed the pattern-maker to make it solid. The head roller, seeing the pattern was solid, went to the pattern-maker to have it changed and made hollow, as he supposed it had been made so by mistake, but the pattern-maker refused to alter it, as he said the "old man" (as they called me 40 years ago) had ordered it to be made that way. "Well," said the roller, "the old man has gone crazy; and if that box is put in as it is the mill will be smashed to pieces, and I am going to see him about it," which he did, and, of course, I told him the box was going in solid, as I would rather have one grand old smash-up once in a while than be constantly annoyed by the breaking of spindles, couplings and breaking-boxes; to which he replied: "Well, you'll get it."

The new mill having been prepared and ready to put in place, the old mill was stopped on the evening of July 3, 1857, and after the Fourth I commenced to tear the old mill out and put the new one in, and also to put in the new engine, while at the same time I remodelled everything about the rail department, and raised the floor-line 2 ft. On the 29th of the same month everything was completed and the mill was ready to be started. I need not tell you that it was an extremely anxious time for me, nor need I add that no engraved cards of invitation were sent out, that not being the custom in the early days of iron-making; and, indeed, if it had been, it would not have been observed on that occasion. As the heaters to a man were opposed to the new kind of a mill, we did not want them about at the start. We however secured one out of the lot, who was the most reasonable one among them, to heat the piles for us, and we kept the furnace smoking for several days as a blind. At last, everything being ready, we charged six piles. About ten o'clock in the morning the first pile was drawn and went through the rolls without the least hitch, making a perfect rail. You can judge what my feelings were as I looked upon that perfect and first rail ever made on a three-high mill; and you may in part know how grateful I felt toward the few faithful men who were about me, and who had stood by me during all my trials and difficulties, among whom were Alexander Hamilton, the superintendent of the mill, and Thomas Lapsly, who had charge of the rail department, William Canam and my brother George. We now proceeded to roll the other five piles. When two more perfect rails had been rolled we were obliged to stop the engine, for the reason that we were so intently watching the rolls that the engine had been neglected, and, being new, the eccentric strap, for want of oil, got hot and bent the eccentric rod so much that the engine could no longer be worked. As it would have taken some time to straighten the rod and reset the valves, the remaining piles were hauled out from the furnace on the mill floor. About this time the heaters, hearing the exhaust of the engine, came into the mill in a body, and from the opposite end to where the rails were. Seeing the unrolled piles lying on the floor, they took it for granted that the new train was a failure; and their remarks about it were far from being complimentary. Mr. Hamilton, coming along about that time, and hearing what they were saying about the mill, turned around, and using language more pointed than polite, told them that if they would go down to the other end of the mill they would see three handsomer rails than had ever been made in their country. The next day, which was Friday, we ran all day, and at night put on the regular night-turn. Everything worked well up to noon of Saturday, it being our custom to stop rolling at that time. About six o'clock in the evening, Mr. Hamilton and myself left the mill, and on our way home we congratulated each other on the fact that our long line of troubles and disappointments was now over. About an hour later I heard the fire-alarm whistle blow, and rushing back to the mill, found it one mass of flame from one end to the other. In less than one hour's time the whole building was burned to the ground, and a story started that the new machinery was a total failure, and that we had burned the mill to hide our blundering mistakes.

The situation of affairs on that Saturday night was such as might appal the stoutest heart; the result of our labors and anxieties lay there a mass of black and smoking ruins, and the money that had been so hard to get with which to build the new works was gone. The prospect was gloomy, but there was one gleam of light amid all the darkness, and that was the pile of new and perfect rails which, as Hamilton had said, had never been beaten by Wales, from which country most of the iron rails used here came. Above all, the mill had been tried and found to work magnificently, and it was these two facts that gave us all fresh courage, and enabled us to rebuild the mill.

The following day, Sunday, was devoted to rest and to thinking over the matter; at any rate, it was not spent in the mill. On Monday morning we commenced to clear up the wreck and to begin the work of rebuilding. In four weeks from that time the mill was running, and made 30,000 tons of rails without a hitch or a break of any kind, thus making the Cambria Iron Company a great financial success, and giving them a rail-mill far in advance of any mill in the United States—a position they held unquestioned until the revolutionary invention of Sir Henry Bessemer came into general use, and steel rails pushed to the wall the rails previously made of iron. I do not now intend to speak of the wonderful change this invention of Sir Henry Bessemer brought about in this country, nor of the enormous increase in the production of rails it made possible. It is but just to say that some credit for this great increase is fairly due to the introduction of the three-high roll-train first erected, amid the most discouraging conditions, in the mill of the Cambria Iron Company at Johnstown 37 years ago.

The use and advantages pertaining to the three-high train were by no means confined to the making of iron or steel rails. Let any practical man go into the iron or steel mills of this country, and he will see, not only how they have served to increase production, but also how in many ways their use has necessitated other improvements, all of which have brought about more perfect work.

If the knowledge we had in the early days of making bar-iron and rails was incomplete and crude, it was not more so than the knowledge displayed in making pig-iron. About 1838 or 1839, Mr. Kunzi, at that time a member of the firm of Farr & Kunzi, large manufacturing chemists in Philadelphia, and one of the ablest chemists of the time, made some experiments with a view of smelting iron with anthracite coal, and about 1842 or 1843 he built a blast furnace on the Schuylkill River at Spring Mill, and after several unsuccessful attempts to make iron in it he sent for Benjamin Perry, a practical furnace-man, to come and take charge of his new furnace, which he did, and succeeded in getting it in good working shape and making fairly good iron.

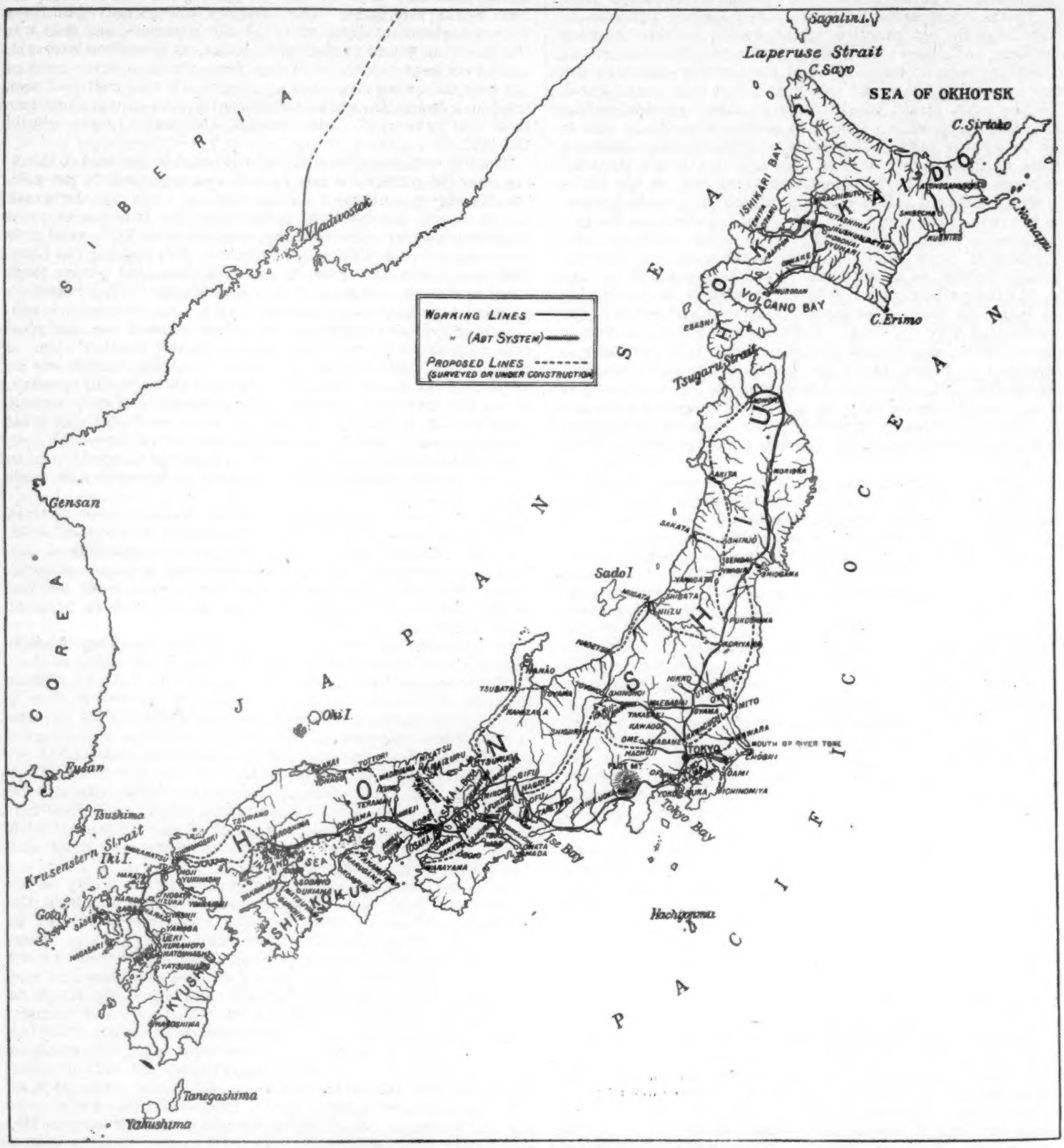
Mr. Kunzi was thereupon congratulating Mr. Perry on his success, and said, that while he himself knew all about the chemistry of iron, he knew nothing about the making of it. To this Mr. Perry replied that he knew nothing about chemistry, but he did know how to make iron. Shortly afterward Mr. Perry thought he could do better by going elsewhere and blowing in other anthracite furnaces, and asked Mr. Kunzi to let him off. This Mr. Kunzi did not wish to do, and he invited Mr. Perry to come up to his house, with a view of trying to induce him to remain. In connection with this, quite an amusing story is told. During the interview Mr. Kunzi talked about the chemistry of iron-making, and of the combustion of coal, etc., and consequently had a good deal to say about oxygen and hydrogen, all of which became rather tiresome to Mr. Perry, who supposed that he had been invited there to have a drink, and he said to Mr. Kunzi: "I don't know a d——d thing about hydrogen or oxygen, but if you have some good Holland gin, I'll take some of that."

Some fifteen years later it was my fortune to have the same founder in charge of the blast-furnaces at Cambria, as even at that time he was looked upon as being the most practical blast-furnace man in the country. While he was with me, my friend, John Griffin, of Phœnixille, paid me a visit, and he wanted to meet Mr. Perry. So I had him come up to my house, where they soon got to talking on blast-furnace practice; and among other things Mr. Griffin asked him about the coal they were using for making coke, to which he replied that it was bad, being full of brass. Mr. Griffin said: "Mr. Perry, you

mean iron pyrites." "Well," said Perry, "you may call it what you d——d please, but I tell you it's brass," and the manner in which he spoke was so emphatic that Mr. Griffin wisely concluded not to pursue any further that branch of the subject. Yet the speaker was the best practical furnace-man that I knew at that time.

Gentlemen, I have already taxed your patience far beyond what I intended when I began this paper; but the subject is one in which I have been greatly interested all my life, and perhaps it is not strange that I have dwelt upon it to the extent I have. Yet, after all, I feel that I have come far short of showing you the real condition of the iron business when I first became connected with it, 56 years ago. I would like to have described the shops and the tools we then had; but time will not permit. The younger members who visit the immense iron and steel plants of the present day will never know how the old-time iron maker managed to get along with only the commonest and crudest tools and appliances, many of which have long since gone out of existence. In the machine-shops in which we built our engines and mills there were very few tools other than the hand-hammer, cold chisel and file; and I must say that, in the hands of the skilful, hard-working mechanics of those days, there was not much they could not accomplish.

I would not feel that I had done my whole duty in my reference to the iron-making of the past, in which I had a part, did I not place on record my admiration of and my obligation to the trusty, faithful and stalwart men whom during these many years, from time to time, I had about me. They were, for the most part, uneducated young men from off the adjoining farms, or had received their training as woodsmen or as workers in the collieries, charcoal furnaces, or bloomeries scattered about in the hills; they knew little of science or of school training; but they were courageous, faithful, hard workers, who knew nothing of short hours or of resting when there was important work to be done, and they had lots of good common sense, which helped them and me out of many a tight place. There were, in addition to the men I have spoken of, and on whom I so much relied in times of break-downs and disasters, a large number of puddlers who, for the most part, in the early days of iron-making, were Welshmen, and in addition to their being skilful iron workers, generally good men and good citizens.




MAP SHOWING THE RAILWAYS OF JAPAN.

It is on such an occasion as this that the roll-call of memory

brings back to me the faces and forms of my early associates who were engaged with me in the various enterprises of which I have spoken. Nearly all have passed away; but I honor the memory of those who have gone, as I thank those still living for all they did to help and encourage me through the trials and anxieties of the past.

## RAILWAYS AND ENGINEERING IN JAPAN.

The accompanying engraving represents a map of Japan, showing the lines of railways. The Japanese Empire consists of four large islands (Hokkaido, Honshiu, Shikoku and Kiushiu) and 407 small islands. (In the map the Kurile Islands on the north and the Loo Choo Islands on the south are not shown.) The north extremity of the Kurile Islands is 50° 56′ north latitude, and the south extremity of the Loo Choo Islands is 24° 6′ north latitude; the east extremity of the Kurile Islands is 156° 32′ east longitude, and the west extremity of the Loo Choo Islands is 122° 45′ east longitude. The total area of the empire is 156,604 square miles, and the coast lines 17,575 miles, including its dependencies. The population is 40,720,000. The general aspect of the country is mountainous and is full of running streams. The largest island, Honshiu, is traversed throughout its whole length by a regular mountain chain, of which Fujiyama is the loftiest peak, attaining an elevation of 12,370 ft. above sea level. The mountain is of a regular conical shape, being an extinct volcano, whose top is covered with perpetual snow. The largest river is Tone-gawa, which is about 2 miles wide near the mouth. The largest lake is Lake Biwa, which is 500 square miles in area, from which a canal was constructed to the city of Kyoto.* The country is full of picturesque scenery.

There are two ocean currents which surround the Japanese Islands. The one is a warm current, called Kuroshiwo, and the other a cold current, Oyashiwo. The former comes from the Philippine Islands, being a continuation of the great equatorial current of the Pacific Ocean, which is deflected from the islands after impinging. This warm current washes the coasts of the Loo Choo Islands and branches into two streams, the principal one flowing along the Pacific coast of Kiushiu, Shikoku and Honshiu, and the other along the Japan Sea coast of these islands. The latter, or cold stream, comes from Kamchatka past the Kurile Islands and flows along the east coast of Hokkaido, and after combining with the warm current sets out to the Pacific Ocean. Owing to this cold stream the southern coast of Hokkaido and the east coast of Honshiu are frequented with dense fogs, which makes navigation difficult. The temperature of the cold current is below 32° F. in winter, and it reaches 60° F. in summer, while the warmer current is 10° higher than the colder current both in winter and summer.

After the revolution in 1868 Japan has undergone a great social, commercial and political change, and the country made a great progress in public works. After the first railway of 18 miles from Shinbashi (Tokyo) to Yokohama was opened in 1872, the line has been and is now being prolonged as follows:

### JAPANESE RAILWAYS.

**Working Lines in Hokkaido.**

| | | Miles. | Chains. |
|---|---|---|---|
| Tanko Railway Company | Temiya-Iwamizawa Line | 47 | 5 |
| | Iwamizawa-Muroran " | 83 | 48 |
| | Oiwake-Yubari " | 26 | 49 |
| | Iwamizawa-Ikushunbetsu Line. | 11 | .. |
| | Horonaibuto-Horonai Line | 2 | 17 |
| | Iwamizawa-Sorachibuto Line | 24 | 75 |
| | Utashinai Branch Line | 6 | .. |
| | | (201 | 34)* |
| Kushiro Railway Company | Shibecha-Atonosanobori Line | 25 | 78 |
| | | 227 | 32 |

**Working Lines in Honshiu.**

| | | Miles. | Chains. |
|---|---|---|---|
| Niphon Railway Company | Ueno (Tokyo)-Awomori Line | 455 | .. |
| | Omiya-Maebashi Line | 52 | 20 |
| | Utsunomiya-Nikko Line | 25 | .. |
| | Akabane-Shinagawa " | 13 | .. |
| | Iwagiri-Shiogama " | 4 | 20 |
| | Oyama Mito Line | 43 | .. |
| | | (592 | 40) |
| Ryomo Railway Company | Oyama-Maebashi Line | 52 | 17 |
| Imperial Government Railways | Shinbashi*Kyoto (Tokaido) Line | 328 | 40 |
| | Kyoto Kobe Line | 47 | 40 |
| | Ofune-Yokosuka Line | 10 | .. |
| | Otu-Taketoyo Line | 14 | .. |
| | Maebara-Tsuruga | 30 | .. |
| | Takasaki-Yokokawa Line | 18 | .. |
| | Yokokawa-Karuizawa (Abt System) Line | 7 | .. |
| | Karuizawa-Naoetsu Line | 92 | 10 |
| | | (547 | 10) |
| Kobu Railway Co | Tokyo-Hachoji Line | 22 | 77 |
| Sobu " " | Ichikawa-Sakura Line | 25 | .. |
| Kawagoe Railway Co | Kokubunji-Kawagoe Line | 18 | 20 |
| Omu " " | Ome-Tachikawa Line | 13 | 7 |
| Sano " " | Kazuw-Koina Line | 9 | 50 |
| Kansei " " | Yokkaichi-Kusatsu Line | 49 | 25 |
| | Kameyama-Tsu Line | 9 | 60 |
| | Yokkaichi-Kuwana Line | 8 | 7 |
| | | (67 | 12) |
| Sangu " " | Tsu-Omata Line | 24 | .. |
| Osaka Railway Co | Osaka-Nara & Sakurai Line | 32 | 55 |
| Hankai " " | Osaka-Sakai Line | 6 | 35 |
| Bantan " " | Himeji-Teramai Line | 18 | .. |
| Sanyo " " | Hiogo-Hiroshima Line | 189 | 62 |
| Total Working Lines in Honshiu (Main Island) | | 1,618 | 65 |

**Working Lines in Shikoku.**

| | | Miles. | Chains. |
|---|---|---|---|
| Sanuki Railway Co | Marugame-Kompira Line | 10 | 15 |
| Iyo " " | Matsuyama-Takahama Line | 5 | 66 |
| | | 16 | 1 |

**Working Lines in Kiushiu.**

| | | Miles. | Chains. |
|---|---|---|---|
| Kiushiu Railway Co | Moji-Hakata-Saga & Kumamoto Line | 136 | 61 |
| Chikuho " " | Wakamatsu, Naogata, Iizuka Kotake & Kaneda Line | 40 | .. |
| | | 176 | 61 |
| Total Working Lines in Hokkaido, Honshiu, Shikoku, and Kiushiu | | 2,038 | 79 |

**Lines Under Construction.**

| | | Miles. | Chains. |
|---|---|---|---|
| Imperial Government Railways | Ou Line (Fukushima, Yonezawa, Yamagata, Akita & Awomori Line) | 298 | .. |
| | Hokuroku Line (Tsuruga-Kanazawa, & Toyama Line) | 124 | .. |
| Tanko Railway Co | Muroran Branch Line | 3 | .. |
| Ota " " | Ota-Mito Line | 12 | 18 |
| Sobu " " | Honjo-Ichikawa Line | 5 | .. |
| Boso " " | Sogano-Oami Line | 11 | 75 |
| Kansei " " | Kuwana-Nagoya Line | 23 | 13 |
| Nara " " | Nara-Kioto Line | 25 | 53 |
| Bantan " " | Teramai-Ikuno Line | 12 | 57 |
| Nanwa " " | Takata-Gojo Line | 16 | 40 |
| Sanyo " " | Hiroshima-Shimonoseki Line | 120 | .. |
| Nanyo " " | Matsuyama-Gunchiu Line | 6 | 57 |
| Dogo " " | Matsuyama-Dogo Line | 3 | 6 |
| Hoshiu " " | Yukihashi-Yokkaichi Line | 43 | 65 |
| Kiushiu " " | Saga, Sasebo, Nagasaki, Kumamoto, Misumi & Yatsushiro Line | 135 | 60 |
| | | 841 | 44 |

**Lines Surveyed.**

| | | Miles. | Chains. |
|---|---|---|---|
| Imperial Government Railways | Chino (or Central) Line. Hackoji-Kofu L. | 54 | 64 |
| | Kofu-Suwa " | 48 | 64 |
| | Suwa-Nagoya " | 129 | 25 |
| | Renraku (or Junction) Line (Himeji-Tottori Sakai Line) | 135 | 27 |
| | Shinonoi Line (Shinonoi-Shiojiri Line) | 41 | 55 |
| | Kagoshima Line (Matsuhashi-Kagoshima Line) | 102 | 66 |
| | Kare Line | 13 | .. |
| | Tsuwano Line | 157 | .. |
| Niphon Railway Co | Kawaguchi-Uchihara Line | 60 | .. |
| | Nakazato-Senji Line | 3 | .. |
| | Mito-Iwanuma " | 130 | .. |
| Sakata " " | Sakata-Shinjo Line | 31 | .. |
| Ganetsu " " | Koriyama Niizu Line | 100 | 70 |
| Hokuetsu " " | Naoetsu-Shibata Line & Niizu-Nuttari Line | 98 | 45 |
| Kano " " | Tsubata-Nanawo Line | 34 | 70 |
| Sobu " " | Sakura-Choshi Line | 42 | 40 |
| Shimosa " " | Sakura-Sawara " | 23 | 30 |
| Boso " " | Chiba-Sogano & Schinomiya Line | 24 | 5 |
| Omi " " | Hikone-Fukagawa Line | 27 | 56 |
| Kyoto " " | Kyoto-Ayabe Wadayama - Ayabe-Maizuru-Miyatsu Line | 100 | 6 |
| Hankaku " " | Kanzaki-Fukuchiyama Line | 63 | 35 |
| Hase " " | Sakurai-Hase Line | 14 | 40 |
| Kisetsu " " | Wakayama-Osaka Line | 40 | .. |
| Kiwa " " | Wakayama-Gojo " | 31 | 20 |
| Kansei " " | Nara-Tsuge Line | 31 | 57 |
| Bantan " " | Ikuno-Wadayama Line | 12 | 76 |
| Sanuki " " | Marugame Takamatsu Line | 17 | 60 |
| Iyo " " | Soga-Ukiana Line | 3 | 14 |
| Chikuho " " | Iizuka-Yamaga-Harada Line | 15 | 65 |
| | Yamaga-Yoshii Line | 14 | 70 |
| | Katsuno Line | 3 | 40 |
| Yamaga " " | Yamaga-Ueki Line | 10 | 42 |
| | | 1,608 | 22 |

* See American Engineer and Railroad Journal, January, 1893.
† In order to avoid complexity, omit the figures within the parentheses.

* Shinbashi is in the southeastern extremity of Tokyo.

ENUMERATION.

| | Miles. | Chains. |
|---|---|---|
| Lines working | 2,038 | 79 |
| Lines under construction | 841 | 44 |
| Lines surveyed | 1,608 | 22 |
| Total | 4,488 | 65 |

In the present Japo-Chinese war these railways are doing great service in sending out an army to Corea and China. The capital hitherto expended for the construction of Japanese railways is about $120,000,000, and much more will be required for proposed future railways. A war fund, amounting to $150,000,000, was voted in the House of Parliament, so that some of the capital intended for new railways will be absorbed by it.

Besides the railways worked by locomotive there are more than a hundred miles of tramways for horse cars. Some of them are going to be changed to electric propulsion, and new lines of electric tramways are also being proposed.

The working railroads serve as mail lines with 28,859 miles of main lines. Over these and the country roads of minor importance millions of carriages are running, which are necessary for transportation in the interior. In addition to these lines of land carriages there are the following mail line steamers on the water:

16,646.83 nautical miles on sea and ocean
120.52 " " " rivers
12.00 " " " lakes

The number of post-offices throughout the empire are 3,704, including 585 of post and telegraph offices. The following figures give the length of government telegraphs in Japan:

Length of lines, 8,639.43 miles } on land.
" " wires, 24,802.48 " }

Length of lines, 211.27 miles } cable under seas.
" " cables, 269.89 " }

Length of lines, 3.44 miles } cable under rivers.
" " cables, 8.52 " }

For the Japo-Chinese war Japanese military telegraphs were constructed in the lands of Corea and China.

There is a telephone exchange in the principal cities in Japan, of which the lengths are:

Length of lines ... 384.10 miles
" " wires ... 3,312.83 "

In addition to these government lines there are some hundred miles of telephone lines belonging to private individuals. The telephone lines at present are of single wires. As the electric tramway is now being constructed in the city of Kyoto, the lines in that city are to be altered to double wires. Electric power is used in the city, and also in mining districts in many provinces.

Within the last eight years electric light companies were formed in principal cities and towns, of which the length of lines are as follows:

Length of lines ... 191.03 miles
" " wires ... 762.45 "

The lines are overhead system, with a minor exception in Tokyo. Most of the electric-light companies are working with steam engines, but some have water-power stations, as in Hakone, Nikko, Maebashi, Kiriu, etc. Besides these lines belonging to companies, there are electric-light plants specially constructed by private individuals, such as in gentlemen's mansions and in mines. There are several kinds of dynamos and lamps used in Japan—Edison's, Thomson-Houston's, Brush's, Bentley-Knight's, Westinghouse's, Siemen & Halske's, Bagnall & Hilles', etc.

In common with other countries, after the adoption of electric lights, gas-lights became of minor importance in Japan. There are now only 23½ miles of gas pipes. Water supply of principal cities and towns is now being improved. There are 250 miles of the approved system of water-works. They are mostly iron pipes, but there are some built with earthenware or wooden pipes.

The system of sewerage in Japan must be improved, especially in cities. But it is a very difficult question to settle upon the system that will suit the peculiar condition of the country. The common water-carrying system is not suitable, as the excreta are used for agricultural purposes.

Concerning the irrigation systems in Japan, travellers are struck with the careful way in which water is supplied to rice fields in every part of the country. In order that the rice fields may be properly supplied from rivers, the river beds are required to be higher than the surrounding fields, which renders the river engineering difficult.

From the nature of the country it will be seen that the physical characteristics of the rivers are very different from other countries. They are mostly mountainous torrents in the upper parts and become sluggish toward the mouth. The quantity of discharge is very small in ordinary condition, but in spring and autumn the state of affairs becomes quite different, when freshets take place as a result of thawing of snow and the long rains. The old Japanese system of protection was levees with crib-work and long bamboo basket-work filled with stones.* Within the last quarter of a century fascine works were introduced, which seem to be preferable in lower parts of Japanese rivers.

The works of harbor engineering have also been carried on within the last fifteen years, and at present the construction of Yokohama Harbor is being executed, the capital for which is for the most part the remuneration of the Shimonoseki battle paid by the American Government. This expenditure of the fund was voted after due consideration by the Japanese Government, for the proper use of an income of such a nature.

As for the Japanese marine, besides 18,293 sea-going vessels of the Japanese style, there are 1,421 vessels of European style, of which 466 are steamships above 100 tons; 703 are sailing ships above 100 tons; 177 steamships below 100 tons; 75 sailing ships below 100 tons.†

The number of small vessels and boats sailing on sea-coasts, lakes, rivers and canals are 585,456, including fishing and pleasure boats. There are arsenals and private dock-yards, where ships, even men-of-war, are made.

The whole coasts of the Japanese Islands are properly illuminated. There are 221 lighthouses, buoys and beacons, besides 3 lightships. Fog signals are also provided in localities subject to fogs of great density. Some of the lights are fixed, while others are revolving or flashing. The height of the lighthouses to the centre of lantern is from 15 to 99 ft., the height of the light above the sea varying from 29 to 397 ft., their range of visibility being from 6 to 20¼ miles.

In regard to the construction of houses, bridges and other works, those which were of temporary character have been and are still being replaced with substantial works, proper consideration being taken for earthquakes, which often visit the country. The architecture of the Western style introduced in Japan is nice, but the nicest is the neatly built houses of Japanese style, a fine specimen of which we have seen in the Wooded Island in the World's Fair.

The mineral wealth of Japan is enormous, and the mining industry of the country made a rapid stride within the last ten years, and the following figures give an idea of the mineral products for one year:

| | |
|---|---|
| Gold | 23,500 oz. |
| Silver | 1,702,000 " |
| Copper | 303,000 piculs |
| Copper sulphate | 460 " |
| Lead | 13,000 " |
| Tin | 800 " |
| Antimony | 54,000 " |
| Arsenic | 1,900 " |
| Manganese | 44,000 " |
| Iron | 25,000 tons |
| Copperas | 15,800 piculs |
| Coal | 3,000,000 tons |
| Sulphur | 443,000 piculs |
| Graphite | 7,600 " |
| Petroleum | 2,020,000 galls. |

The annual mineral products amount to about $20,000,000, and these minerals seem almost inexhaustible in the islands.

The development of the manufactures in the country is observed by travellers, who meet with many workshops and chimneys in different provinces. There are splendid silk factories, spinning and weaving works, rice-refining works, paper mills, iron works, cement manufactories, brick manufactories, porcelain working shops, tea-making shops, glass works, oil and other chemical manufactures, etc., which are well organized.

In the national exhibition which is to be opened in Kyoto in April, 1895, in celebration of the eleven hundredth anniversary of the Emperor Kammu, the advancement of engineering and manufactures within the last five years will be seen. Now is the time that the tide of wealth is flowing toward the Land of the Rising Sun in the Far East.

* See AMERICAN ENGINEER AND RAILROAD JOURNAL for November, 1894.

† The steamers of steamship companies make regular trips on the coasts of Japan. The Niphon Yasen Kaisha is the largest company who has full-powered steamers carrying mails and excellent accommodations for passengers. The steamers of the Company make regular trips to the coasts of Corea, China, Siberia, and to Bombay.

## WATER-TUBE BOILERS AND THEIR APPLICATION TO WAR VESSELS.*

By J. Nastoupil.

*(Concluded from page 36.)*

XI. The Normand boiler (fig. 31) is very similar to the Thorneycroft boiler in its general design. Like the latter, it consists of two horizontal water drums and a steam drum of round cross-section lying above it, to which a steam dome is added. The heating tubes are also curved, but they are fastened into the lower side of the steam drum, so that their ends are below the water-line. There is also a variation in the

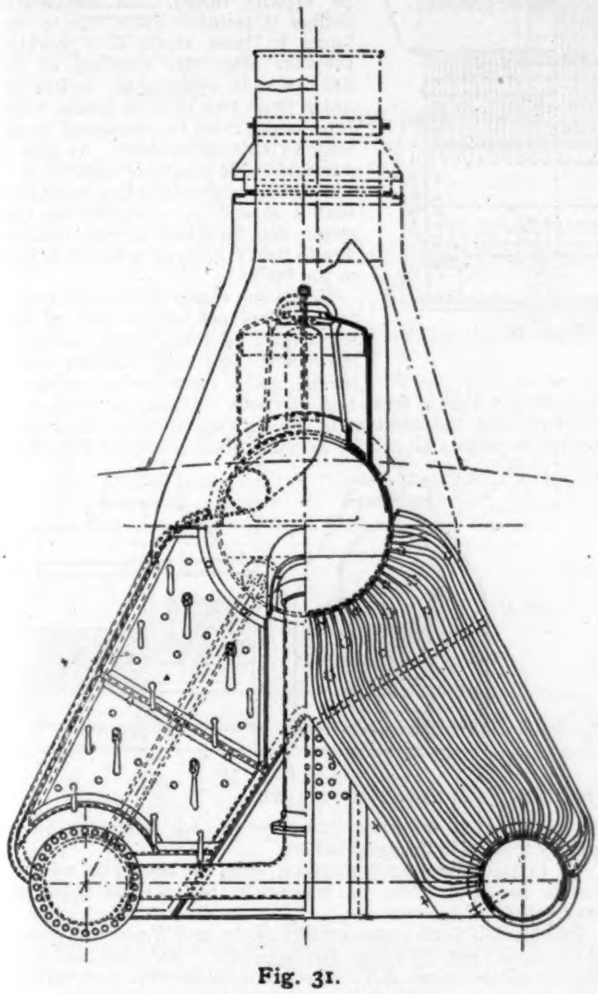


Fig. 31.
THE NORMAND BOILER.

construction of the circulating tubes which are placed at each end of the boiler.

XII. The Du Temple water-tube boiler (fig. 32) consists, like the Thorneycroft and Normand boilers, already described, of two horizontal water drums and a horizontal steam drum lying above it, which is connected with those first named by a number of thin water tubes and by two circulating tubes led down outside of the casing. The two water drums have a comparatively small rectangular cross-section, and are fitted throughout their whole length with hand-holes, through which access to the inside is gained. The water tubes, which have the zigzag form shown in the engraving, enter the steam drum below the normal water-level. As the grate is set between masonry walls, all of the water tubes lie above the fire, and the products of combustion pass across them.

XIII. The Fleming & Ferguson water-tube boiler (figs. 33–37) has two or more cylindrical water drums beneath, while a steam drum of a larger diameter is placed above them. Each water drum is connected to the steam drum by bent tubes of from ½ in. to 2½ in. in diameter, wherein the arrangement of tubes is such that in case any tube should become damaged it can be drawn out into the steam space, from which another can be put in position. For this purpose especial spare lengths of tubes can be kept on hand, which in case of necessity can be cut to a proper length. The ends of the tubes are made fast in the shells of the cylinders by rolling.

This type of boiler can be constructed either as a single or as a double boiler; in the latter case the furnaces can be arranged either at the sides or at the two ends. The boiler casing consists of two plates of sheet metal with the intervening space filled with asbestos.

Water-tube boilers of this type have been built for a working pressure of 300 lbs. per square inch, and have been tested by a hydrostatic pressure of 650 lbs. per square inch.

XIV. The White water-tube boiler (figs. 38–41) consists of two water drums and a steam drum, which is cylindrical in form and located above the two others. Both water drums have as their main connection to the steam space a set of spiral water tubes, each two of which forms an element. The whole boiler is enclosed in a double-walled sheet metal casing, whose back wall is protected by a range of tubes, which consists of special water tubes set close together. In order to insure circulation of the water, the back end of the boiler is furnished with circulating pipes that drop down outside of the casing. The furnace is enclosed between two tubular side walls which are formed of water tubes set close together.

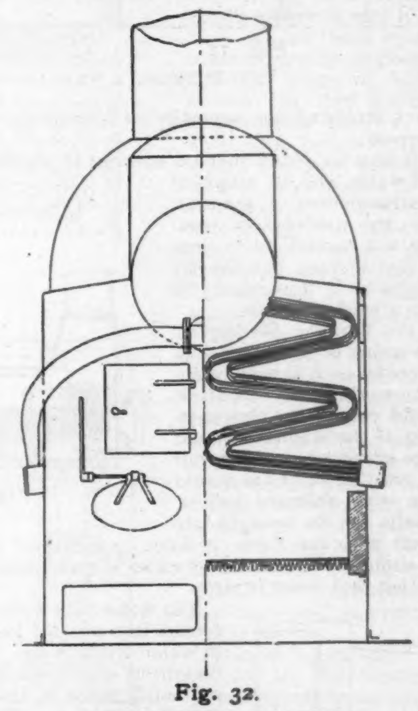


Fig. 32.
THE DU TEMPLE BOILER.

The products of combustion first rise from the grates and pass to the back wall, and are then turned in the opposite direction through side passages on either side toward the front where they rise into two smoke-stacks.

#### ADVANTAGES OF THE WATER-TUBE BOILER.

The advantages which the water-tube boiler possesses over the ordinary cylindrical boiler can be treated under three heads, as follows:

*a. From a Constructive Standpoint.*—For an equal factor of safety against explosion, the thickness of the walls of the tubes of water-tube boilers can be very much thinner than the shells of ordinary boilers, whereby a boiler can be constructed for a higher working pressure of steam than that for which the shell and heating surfaces of the ordinary boiler can be made without an excessive thickening of the material, where the safety is jeopardized by the use of sheets that are defective, either from lack of homogeneity, bad manipulation in shaping or other constructive defects.

Outside of the great saving in weight that can be achieved, water-tube boilers require, on account of the compactness of their construction, less space, and carry, in consequence of their smaller volume, a lesser weight of water.

* Paper read before the Wissenschaftlichen Verein der k. und k. Kriegsmarine.

Water-tube boilers can be built in separate parts, which makes them easily transported; and this special type is further available where a change of boilers must be made in a ship without involving the necessity of tearing up the deck for this purpose.

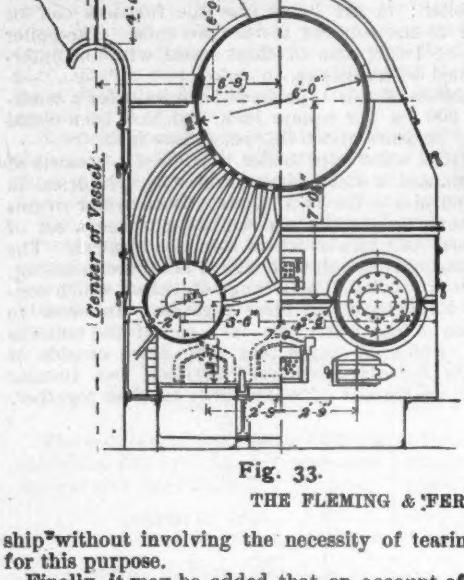



Fig. 33.

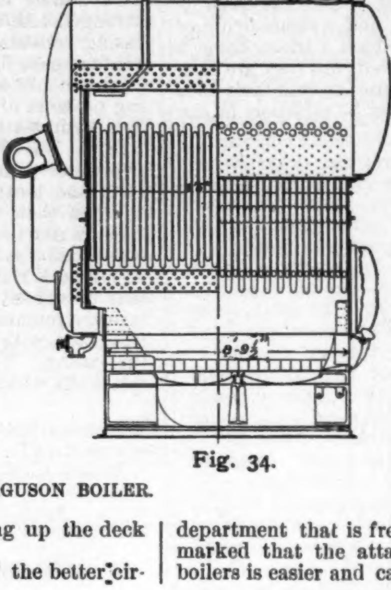


Fig. 34.

THE FLEMING & FERGUSON BOILER.

Finally, it may be added that on account of the better circulation of water, and by reason of the better arrangement of the heating surface, the products of combustion are not carried on in lines parallel to that surface, but directly at right angles to it, thus raising its efficiency to a marked degree.

*b. From the Working Standpoint.*—As the working of the boiler is of the first importance, it is very essential that the working of water-tube boilers should receive the closest attention; yet, if the attention should be slack, the efficiency does not fall away to so great an extent as would be the case with ordinary boilers. The thin walls can be brought into direct contact with the flame without any danger, provided only that a sufficient circulation of water is maintained in the boiler, and that that water is pure.

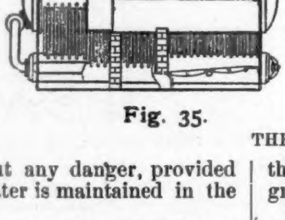


Fig. 35.

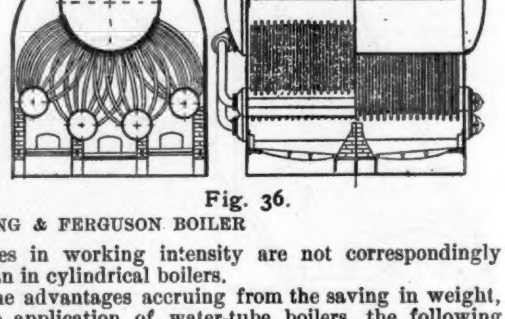


Fig. 36.

THE FLEMING & FERGUSON BOILER

The water-tube boiler can be forced into a rapid generation of steam without any of those disastrous consequences which ordinarily occur in the case of cylindrical boilers. The vigorous circulation of the water maintains all parts at a practically even temperature, prevents the formation of scale on the heating surfaces and assists in the liberation of the steam.

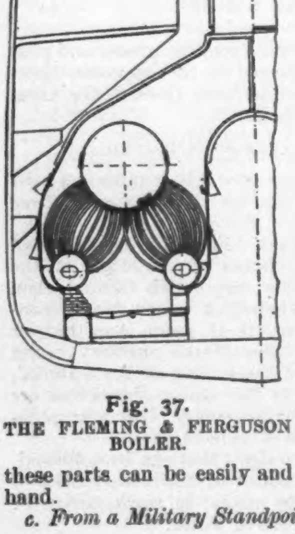


Fig. 37.
THE FLEMING & FERGUSON BOILER.

The defects that occur in water-tube boilers are mostly of a local nature, and the damages resulting therefrom will, on account of the small quantity of water in the boiler, be very much less than in the case of other types. Worn-out or damaged water-tube boilers can be easily and quickly changed on board, so that the interruption in service will be correspondingly diminished.

As water-tube boilers consist of a number of similar parts, these parts can be easily and without inconvenience kept on hand.

*c. From a Military Standpoint.*—The rapid raising and generation of steam without producing any bad results, as can be done with water-tube boilers, is a matter that is intimately connected with the fighting capabilities of a battle-ship.

Let us compare two equally large battle-ships, one of which is fitted with cylindrical or locomotive types of boilers, whereas the other is equipped with water-tube boilers. The latter, instead of lying under steam, in expectation of the enemy, whereby it will quickly exhaust its coal supply, will know that under the circumstances the boilers can be allowed to cool off, and that as soon as the necessity may arise steam can be rapidly raised. In locomotive boilers it requires from one to two hours to raise steam to a working pressure after the kindling of the fire; simple cylindrical boilers require from two to three hours, while four hours must be consumed in the large cylindrical boilers. As this is a considerable length of time, it is of the highest importance to a battle-ship that it should be equipped so that steam can be raised in from twenty-five to thirty minutes without injury to the boiler.

Hence the vessel fitted with water-tube boilers can, at the end of this short space of time, begin its operations with full coal bunkers, clean boilers, and a crew in the engineer's department that is fresh and vigorous. It may be further remarked that the attainment of full speed with water-tube boilers is easier and can be accomplished more quickly, since the changes in working intensity are not correspondingly greater than in cylindrical boilers.

As to the advantages accruing from the saving in weight, due to the application of water-tube boilers, the following data will be of interest:

The Danish third-class cruisers *Hecla* and *Geiser* are vessels of the same type, of equal displacement (1,300 tons), and with engines of the same H.P. Both are fitted with two vertical triple-expansion engines, but the boilers are different. On the *Hecla* there are six cylindrical boilers, while on the *Geiser* there are eight Thorneycroft water-tube boilers. In both cases the boilers were designed to supply steam for 3,000 I.H.P., and their weights are as follows:

| | *Hecla.* | *Geiser.* |
|---|---|---|
| Boiler with tubes, feed pumps, breeching, stacks, and all necessary fittings | 120.2 tons. | 90.8 tons. |
| Water contained in boiler | 48.0 " | 17.4 " |
| Total | 168.2 tons. | 108.2 tons. |

There is thus a saving of 60 tons, or more than one-third in the weight of the boilers of the *Geiser* over those of the *Hecla*. According to the official report regarding the performance of the former, 3,157 I.H.P. was maintained with a consumption of 35 lbs. of coal per square foot of grate surface, with an air pressure in the fire-room of 0.81 in. water column. In the official report to the Danish authorities, Captain Nielson says:

"During the test the boilers worked remarkably well, and the steam pressure was maintained with the greatest ease. The steam production could be instantly regulated to correspond with the consumption of the engine by means of the steam cut-off valve of the fans.

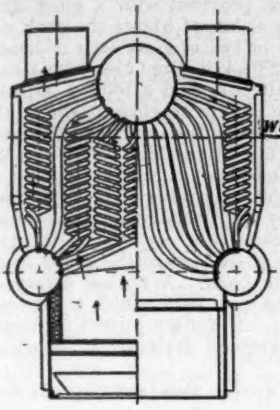



Fig. 38.

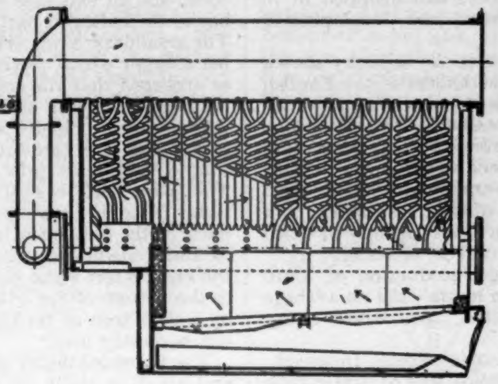


Fig. 39.

THE WHITE BOILER.

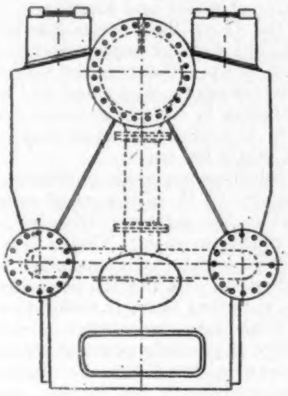


Fig. 40.

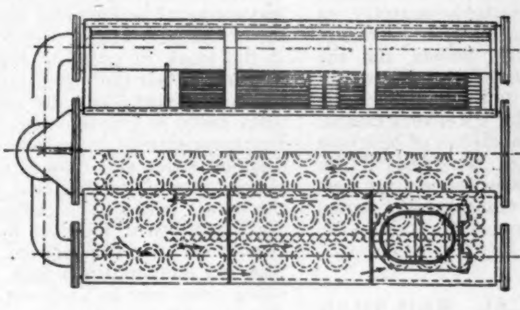


Fig. 41.

THE WHITE BOILER.

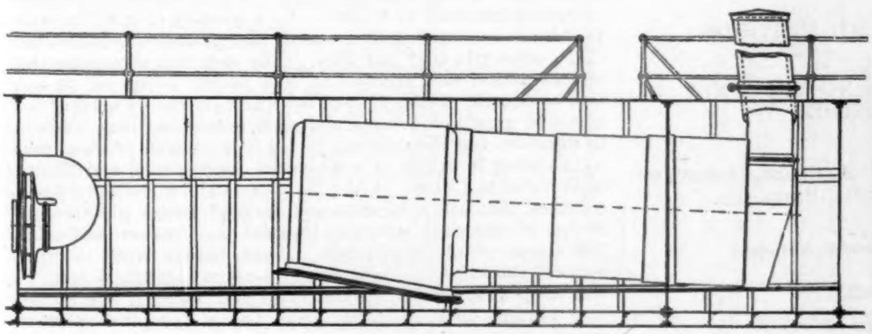


Fig. 42.

THE LOCOMOTIVE BOILER.

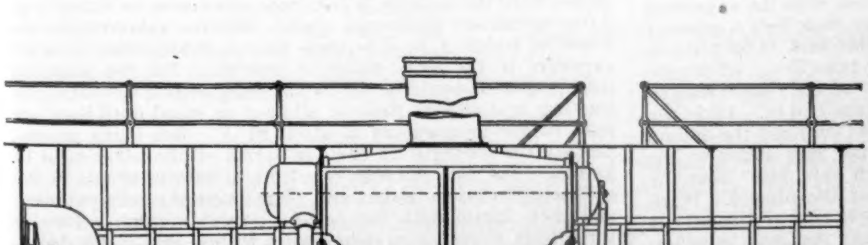


Fig. 43.

THE THORNEYCROFT BOILER.

"After a run of more than seven hours and a half at sea, as well as at the conclusion of the test, the engine could be brought up to 3,314 I.H.P. at once by the use of an air pressure equivalent to .6 in. of water, and the steam production for this high service could be maintained by a pressure of 1 in. of water.

"We frequently made sudden stops of the engine while at full speed, and could bring the vessel back to full speed again in a few minutes without paying any particular attention to the boilers, since they were in a condition to sustain sudden changes of temperature. The boilers primed neither during the greatest forcing nor when there was a sudden change made in the work of the engine.

"The *Geiser* can make ready to start in three-quarters of an hour, and could do it in half an hour if so much time were not required for warming the engines."

The English torpedo boats *Havock* and *Hornet*, each of which has a length of 180 ft. and a beam of 18 ft. 6 in., are both equipped with triple-expansion engines, but have different types of boilers. The *Havock* has two locomotive-form boilers, while the *Hornet* has eight water-tube boilers of the Yarrow type. The total weight of the boilers and attachments in the *Havock* is 54 tons, and in the *Hornet* 43 tons, giving the latter a saving in weight of 11 tons. Both vessels were built by the same firm (Yarrow & Co.), who guaranteed one knot higher speed for the *Hornet*.

For the *Havock* it was guaranteed that on a three hours' trial the engines should develop 3,200 I.H.P., with a steam pressure of 165 lbs. per square inch, and with from 2 in. to 3 in. of water pressure should exceed it by 200 I.H.P.; while on the *Hornet*, in a run of the same duration and with a steam pressure of 169 lbs. per square inch, with an average air pressure of 1½ in. of water, a mean efficiency of 4,000 I.H.P. was maintained, which gave the vessel an average speed of 27.628 knots.

The saving in space which was effected by the substitution of a Thorneycroft water-tube boiler in place of a locomotive-form boiler of the same capacity, whereby a saving of 4 tons in weight was also obtained, is shown in figs. 42, 43.

The remarkable changes of temperature that can be wrought in water-tube boilers are well shown by the following test:

A separate trial of a water-tube boiler for the torpedo-boat *Hornet* was made on shore, when within twenty minutes and twenty seconds from the time of kindling the fire a pressure of 180 lbs. per square inch was obtained, and this pressure was maintained for half an hour by opening the fan valve to its full width and using an air pressure of from 3 in. to 3½ in. of water, while the amount of steam drawn off corresponded to that which would be required by an engine developing about 780 I.H.P. Then, in a space of six minutes, the fire was hauled and the boiler

allowed to cool off with the fire-doors open, so that after a lapse of thirty-two minutes the pressure had dropped to 70 lbs. per square inch without the slightest leak developing in any part of the boiler.

It is also worthy of our attention to note the capacity shown several years ago in a test made of the boilers of the English torpedo-boat *Speedy* of 810 tons. This vessel was built by the firm of Thorneycroft & Co., and contained eight water-tube boilers designed for a working pressure of 250 lbs. per square inch. According to the contract, there was to be a test of eight hours' duration, showing an average capacity of 2,500 I.H.P., with a maximum air pressure of 3 in. of water, and a test of three hours' duration giving a mean capacity of 4,500 I.H.P., with a maximum air pressure of 5 in. of water.

In the eight hours' test an average production of 3,046 I.H.P. was obtained, and in the three hours' trial an average of 4,700 I.H.P. was obtained, and that, too, without any special forcing.

The navies of France, England, Russia, Spain, Denmark, and the United States are making applications of water-tube boilers in considerable numbers to vessels of all sizes. On large ships the Bellville or Lagrafel d'Allest boilers are used of about equal sizes, while upon the smaller craft the Oriolle, Du Temple, Normand, Thorneycroft, Yarrow, and other boilers of a similar type are applied.

The necessity of economizing space, and at the same time securing a large heating surface with the least possible amount of material, together with a greatest available capacity, as well as insensibility to variations in the intensity of working, show the principal advantages of water-tube boilers, and the reason why they are receiving a continually increasing application to the new vessels that are being built by most of the naval powers. Water-tube boilers also offer a welcome means, if it is desired, of clearing a ship when a change of boilers is required, of insuring the maintenance of its speed, if not actually increasing it, and of gaining space for a given service, thus increasing the cargo space or enlarging the radius of action.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

### Chemistry Applied to Railroads.

### SECOND SERIES.—CHEMICAL METHODS.

### XIII.—METHOD OF DETERMINING AMMONIA IN AMMONIUM CHLORIDE.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.



(*Continued from page* 33.)

#### OPERATION.

Have ready the apparatus shown in accompany cut or its equivalent. Put 25 c.c. of standard sulphuric acid into the smaller Erlenmeyer flask, and connect this with the apparatus as shown. Then weigh into the larger flask half a gram of the ammonium chloride, and connect this flask in its place as shown. Then add through the funnel tube 75 c.c. of caustic potash solution, and close the stop-cock of the funnel tube as soon as all the caustic potash solution has run in. Light the lamp, and bring the liquid to a boil, and continue the boiling gently until about 50 c.c. of liquid has been added to the smaller Erlenmeyer flask. Now detach this flask from the rest of the apparatus at the top end of the pipette. Wash out the pipette on the inside and the lower part of the outside with distilled water, to remove any liquid that may be adhering to it; also wash down the sides of the flask and allow to cool. Then titrate the excess of free sulphuric acid in this flask with standard caustic potash solution, using methyl-orange as indicator.

#### APPARATUS AND REAGENTS.

The special apparatus required by this method consists, as is seen, of a 16-oz. Erlenmeyer flask fitted with a rubber stopper, which carries a funnel tube provided with a glass stop-cock, and an exit tube which is enlarged above the cork and has in the enlarged part an inch or two of glass balls or beads. The smaller or 8-oz. Erlenmeyer flask is fitted also with a rubber stopper which carries an exit tube and a 100 c.c. pipette, so arranged that the end of the pipette reaches almost to the bottom of the flask and always below the surface of the acid. The top of the pipette and the top of the exit tube from the 16-oz. flask are connected by means of a rubber stopper, a simple bent glass tube and a bit of rubber hose as shown. The 16-oz. flask is supported by a universal clamp on a retort stand in such a way that the glass tube connecting the two parts of the apparatus inclines a little toward the larger flask, to allow condensed water to run back. A second clamp on the same retort stand sustains the sand bath, which is adjusted to the bottom of the 16-oz. flask. A Bunsen burner protected by a sheet-iron or tin shield to keep off drafts of air furnishes the necessary heat.

The phenolphthalin solution used in standardizing the acid and alkali is made by dissolving 5 grams of the commercial material in 100 c.c. of 95 per cent. alcohol, and adding caustic potash until the solution shows a slight pinkish tint.

The methyl-orange solution is made by adding 1 gram of the commercial material to 400 c.c. of water and filtering.

The potash solution used in the 16-oz. flask is made as follows: Take a beaker holding about 40 fluid ounces and put a mark on the outside at 30 oz. capacity. Put into the beaker 200 grams of commercial caustic potash in sticks and add 36 oz. of distilled water. After solution is complete, boil down to the mark in order to remove any ammonia that may be present. Pour the liquid into a bottle for use.

The standard alkali and acid solutions are made as follows: Take about 50 grams of the best dry C. P. carbonate of soda, free from silicate, to be obtained in the market. Dissolve in distilled water and filter into a platinum dish. This is to remove any sand or dirt that may be accidentally contained in the soda. Add a little carbon dioxide, or a few drops of carbonic acid water, in order to be sure that there is a slight excess of carbonic acid present. Evaporate the solution to dryness at a temperature a little above the boiling point of water, using great care to keep out dust or dirt. When thoroughly dry transfer to a dry glass-stoppered bottle for further use. Now carefully weigh a clean ½-oz. platinum crucible, and add to it not quite a gram of the dried carbonate of soda, ignite over a Bunsen burner until the soda is just melted and weigh. This weight gives the amount of carbonate of soda used, and is the basis of the standardizing. Have previously prepared two solutions made as follows: 1. A solution of distilled water to which has been added about 26.5 grams of concentrated C. P. sulphuric acid per litre. The solution should be thoroughly mixed and allowed to cool before using. 2. A solution of caustic potash in distilled water, made by adding to it about 50 grams of commercial stick potash per litre, allowing to dissolve, and then adding to it ½ litre of milk of lime, made by slacking 70 grams of commercial caustic lime, and diluting with water to 1 litre. After the lime is added, boil for 10 or 15 minutes, then allow to settle and draw off with a pipette about 50 c.c. of the clear solution, transfer to a beaker, and add a few drops of phenolphthalin. Then run in from a burette some of the sulphuric acid solution above described, until the last drop just discharges the color and boil. If 5 or 10 minutes boiling does not bring back any of the pink color, the caustic potash solution may be regarded as free from carbonates and is ready to be proceeded with. If boiling does restore any of the pink color, the boiling with the lime must be continued, or fresh milk of lime added and boiling continued until the solution is free from carbonates by above test. After carbonates are proven absent, filter the solution into the vessel in which it is to be kept for use, taking care to avoid exposure to the air as much as possible. The two solutions thus prepared should be rendered homogeneous by stirring or shaking, and should then be allowed to stand until they are both of the temperature of about 80° F.; this being accomplished the strength of each in terms of the other must be known. For this purpose run from a burette 40 c.c. of the acid solution into a beaker, add a few drops of phenolphthalin, and then titrate with the caustic potash solution. Two or three tests should give same figure within one or two drops. Preserve the figures thus obtained. Now put the crucible containing the fused carbonate of soda before described into a beaker, add about 50 c.c. of distilled water, and allow to dissolve. Then add about 40 c.c. of the sulphuric acid solution above described and boil 15 minutes to remove carbon dioxide, taking care that there is no loss due to effervescence. After the boiling is finished, titrate the excess of acid with the caustic potash solution, using phenolphthalin for the indicator. The relation of the acid and alkali being known as before de-

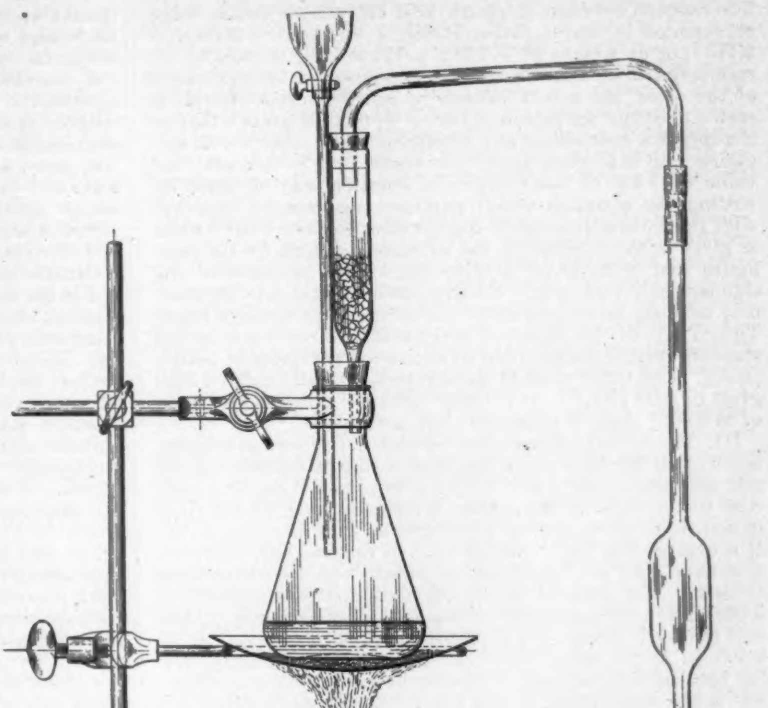
scribed, it is easy to find the amount of the sulphuric acid solution, corresponding to the carbonate of soda taken. But one point still remains uncertain—viz., whether the boiling has removed all the carbon dioxide. To decide this point add to the solution which has just been titrated with the potash solution, and which the last drop of potash rendered pink, one drop of the acid solution, or enough to just completely discharge the color and boil again. If the color does not reappear on boiling, the figures already obtained may be regarded as satisfactory. If the color does reappear, run in 1 or 2 c.c. of the acid and boil again. The amount of acid thus run in must be added to the 40 c.c. used at first. After boiling, say 5 minutes more, titrate with the potash solution, noting how much of it is required to bring back the pink color, and adding this amount to the amount of potash solution previously used. Now test as before for the absence of carbon dioxide, and if it is proven not present, find the total number of c.c. of the sulphuric acid solution which are equivalent to the carbonate of soda used. From this, as described below, the amount of sulphuric acid [$H_2SO_4$] in 1 c.c. of the acid solution may be obtained. But convenience in the subsequent use of the acid solution makes it desirable that each c.c. of it should contain a definite proportion of the molecular weight of sulphuric acid, say one-fourth or 0.0245 grams, $H_2SO_4$. If sufficiently concentrated C. P. sulphuric acid has been used in making the solution to start with, the figure obtained as above will be larger than this, and as shown in the calculation below, a certain amount of water must be added, which should be done, the solution being agitated by stirring or shaking, and then allowed to stand until the following day, when a new determination of its strength should be made by means of carbonate of soda as above described. The figure thus obtained will show whether further addition of water is necessary. When all the water needed has been added, not less than two determinations of the strength of the acid should be made by means of carbonate of soda, as described above, which duplicates should show the value of 1 c.c. to be not less than 0.0244 gram nor more than 0.0246 gram of sulphuric acid [$H_2SO_4$].

The standard acid having been obtained, it remains to make the caustic potash solution so that 1 c.c. equals 1 c.c. of the acid solution. For this purpose run, say, 40 c.c. of the standard acid into a beaker and titrate with the caustic potash, using phenolphthalin as indicator. If fairly good caustic potash has been used in making the solution, this operation will show that water must be added. If the operation shows that the solution is too weak, it is better to throw it away and start again, using more of the potash per litre. The figure obtained enables, as is shown below, the amount of water that must be added, to be calculated. This amount of water should be added, the solution agitated by stirring or shaking, and allowed to stand until the following day, when a new test should be made. The figure thus obtained will show whether further addition of water is necessary. After all the water has been added, not less than two tests should be made, and each of these should show that the two solutions are alike to within one-tenth of a c.c. in 40.

### CALCULATIONS.

An example of all the calculations is given herewith. Atomic weights used: nitrogen, 14; hydrogen, 1; potash, 39.1; sulphur, 32. Molecular formula: ammonium chloride, $NH_4Cl$; ammonia, $NH_3$; caustic potash, KOH; sulphuric acid, $H_2SO_4$; water, $H_2O$.

I. Standardizing the sulphuric acid. Suppose that 40 c.c. of the sulphuric acid as mixed requires 36.4 c.c. of the caustic potash as mixed to exactly neutralize it, this figure having been obtained by two or three closely agreeing tests. This means that 1 c.c. of the sulphuric acid solution is equal to [36.4 ÷ 40] 0.91 c.c. of the potash solution, and that 1 c.c. of the potash solution is equal to [40 ÷ 36.4] 1.0989 c.c. of the acid solution. Next, suppose the fused carbonate of soda in the crucible weighs 0.9864 gram, and that 45 c.c. of the sulphuric acid as mixed are run into the solution of this carbonate of soda; also that after boiling it requires 9.2 c.c. of the potash solution to neutralize the excess of acid; also that it is found that the carbon dioxide is not quite all removed by the first boiling, and that 1 c.c. more of the acid is put in for the second boiling, and that after this second boiling it requires 0.4 c.c. of the potash solution to neutralize the excess of acid, and that test shows that the second boiling removed all the carbon dioxide. It is evident that 46 [45 + 1] c.c. of the acid have been used altogether, and that 9.6 [9.2 + .4] c.c. of the potash solution have been used to neutralize the excess of acid. But 1 c.c. of the potash solution is equal to 1.0989 c.c. of the acid, or 9.6 c.c. of the potash solution are equal to [1.0989 × 9.6] 10.55 c.c. of the acid solution. Hence the amount of the acid solution used up by the 0.9864 gram of carbonate of soda is 35.45 [46 − 10.55] c.c. or 1 c.c. of the acid solution is equivalent to [0.9864 ÷ 35.45] 0.027825 gram carbonate soda. But the ratio of the molecular weights of carbonate of soda [$Na_2CO_3$] to sulphuric acid [$H_2SO_4$] is as 106 to 98. Hence each c.c. of the sulphuric acid solution contains [106 : 98 :: 0.027825 : $x$] 0.025725 gram sulphuric acid. But, as previously stated, it is more convenient to have the acid and alkali solutions some even ratio of the molecular weight, and therefore a solution is wanted which contains [98 ÷ 4] 0.0245 gram of sulphuric acid per cubic centimetre. To obtain this water must be added to the solution in question. The amount of this is found by the following ratio, $a : b :: x : c$, in which $a$ represents the strength of the acid as determined, in this case 0.025725 gram, $b$ the strength of the acid desired, in this case 0.0245 gram, $c$ the total volume of the solution we are working with, say 15000 c.c., and $x$ the volume of the solu-



APPARATUS FOR DETERMINING AMMONIA IN AMMONIUM CHLORIDE.

tion after the water is added, which in the case supposed is [0.025725 × 15000 ÷ 0.0245] 15750; or [15750 – 15000] 750 c.c. of water must be added.

II. Standardizing the caustic potash solution. Suppose that it is found that 40 c.c. of the standard acid requires 31.2 c.c. of caustic potash solution as made to exactly neutralize it. This means that water must be added and the amount may be found by the proportion $a : b :: x : c$, in which $a$ represents the number of c.c. of standard acid used, in this case 40, $b$ the number of c.c. of potash solution used, in this case 31.2 c.c., $c$ the total volume of the solution we are working with, say 15000 c.c., and $x$ the volume of the solution after the water is added, which in the case supposed is [40 × 15000 ÷ 31.2] 19230, or [19230 – 15000] 4230 c.c. of water must be added. The reaction between sulphuric acid and caustic potash being represented by the equation $H_2SO_4 + 2\,[KOH] = K_2SO_4 + 2[H_2O]$ or by weight 98 + 112.2 = 174.2 + 36, it must be remembered that, since 1 c.c. of each solution is the equivalent of the other, the actual amount of caustic potash [KOH] in each c.c. of the solution is [112.2 ÷ 4] 0.02805 gram; that is, if a solution containing any substance which reacts with sulphuric acid is so made that 1 c.c. equals 1 c.c. of the acid, the value of 1 c.c. of the solution in question may be found by writing the equation which expresses the reaction, together with the molecular weights, and dividing the molecular weight as given in the equation of the substance sought by the same figure that is required to give the known strength of the standard sulphuric acid. Further, the quotients thus obtained may be used interchangeably according to the work in hand. Thus 1 c.c. of the standard sulphuric acid, or 1 c.c. of the standard caustic potash, is equivalent to 0.02355 gram of potash [$K_2O$], or to 0.020 gram of caustic soda [NaOH], or to 0.0155 gram of soda [$Na_2O$], or to 0.0265 gram of carbonate of soda, or to 0.0085 gram of ammonia [$NH_3$].

III. Ammonia in ammonium chloride. Suppose, as is noted below, that methyl-orange has been used in standardizing the acid and alkali, and that 1 c.c. of acid equals 1 c.c. of alkali. Also that 6.6 c.c. of the caustic potash solution are required to neutralize the excess of sulphuric acid in the 8 oz. flask. It is evident that [25 — 6.6] 18.4 c.c. of the standard sulphuric acid have been used up by the ammonia from the ammonium chloride. But each c.c. of the standard acid is equivalent to 0.0085 gram of ammonia, consequently the ammonia in the half gram is [0.0085 × 18.4] 0.1564 gram, or [0.1564 × 100 ÷ 0.500] 31.28 per cent. If, on the other hand, phenolphthalin has been used as indicator in standardizing the acid and alkali, and it has been found, as described below, that 50 c.c. of the standard acid require 49.5 c.c. of standard potash when methyl-orange is used as indicator, it is evident that 1 c.c. of the potash equals [50 ÷ 49.5] 1.0101 c.c. of the acid. But under these conditions with methyl-orange as indicator, it would require 6.53 c.c. of potash to neutralize the acid left in the flask in the case supposed above, or [6.53 × 1.0101] 6.6 c.c. of the acid are neutralized by the potash, showing as before [25 – 6.6] 18.4 c.c. of the acid neutralized by the ammonia; the remainder of the calculation is as above.

### NOTES AND PRECAUTIONS.

It will be observed that this method separates the ammonia from the ammonium chloride by decomposing it with caustic potash, removing it from the solution by boiling and catching the ammonia gas along with some of the condensed water in standard sulphuric acid solution, no special condenser or aspirator being required.

If the boiling is conducted too rapidly, some of the water on the glass beads or balls is apt to be carried along mechanically, and may find its way into the acid flask. This water is principally condensed steam, but may contain some of the potash solution mechanically carried along from the boiling solution below. The error introduced by any of the potash solution getting into the acid solution is obvious.

On the other hand, if the boiling is too slow, especially toward the last of the operation, when the whole apparatus is filled with steam and the acid has become somewhat warm, or if a cold draft of air strikes the apparatus, there is a tendency for the acid to be sucked back toward the alkali flask. The 100-c.c. pipette allows all the acid to be sucked up into the bulb without any of it getting back into the alkali flask, but there is danger of error if air is allowed to bubble back through the acid solution in the bulb, since some of this solution may be carried mechanically by the air bubbles back into the alkali flask. By having the apparatus in a quiet place, and managing the heat properly, the absorption of the ammonia takes place quietly and there is no regurgitation.

After a test has been finished it is essential to wash out the whole apparatus and to remove the glass stopcock in the funnel tube, otherwise this stopcock becomes fast.

Much of the phenolphthalin of the market apparently contains something which combines with alkali, without showing change of color. If this is not satisfied with alkali as directed, the reaction will not be quite so delicate.

Standard sulphuric acid solution is made by adding to a clean clear glass 5-gall. bottle 15 litres of distilled water, and then weighing out and adding to it 397.5 grams of concentrated C. P. sulphuric acid. It is better to set the water in the bottle in motion by stirring with a clean glass rod before adding the sulphuric acid. After the acid is in it is essential to agitate thoroughly by stirring and shaking, but not advisable to draw air through for this purpose, as this causes the liquid to take up carbon dioxide, which interferes with its subsequent usefulness with phenolphthalin. It is not desirable to standardize on the same day, both on account of temperature, and also because it is very difficult by any practicable method of agitation to get so large a bulk of liquid entirely homogeneous without standing. If the first standardizing shows that it is essential to add, say, 750 c.c. of water, it is better to add only 700, since the liquid should be standardized once more any way, and too much water must of course be avoided. The second addition of water is usually less than 100 c.c. Both agitation and standing over night are essential after each addition of water.

Caustic potash solution is made in the same kind of bottle and in the same amount as the acid solution. The same precautions should be taken in regard to stirring, and allowing to stand over night, as in the case of the acid. It is well known that caustic potash solution, if properly made as above described, contains a small amount of caustic lime in solution. Of course this lime will appear in the comparison with the standard acid. If now the water used in the first addition contains a little carbon dioxide, a little of the lime will be precipitated on standing over night and weaken the solution a little. It is therefore not advisable to add quite as much of the water shown by calculation the first time, as in case of the acid.

The two solutions, as will be observed, are made in quite large amounts, and considerable pains are taken to have them right, since other work depends upon them. Both of the solutions are kept on a shelf somewhat higher than the burettes, and both are drawn into the burettes by means of glass tube syphons with glass cocks at the lower ends. In accurate work it is of course essential to draw out and throw away the liquid which has been standing exposed between the cock and the lower end of the syphon tube before filling the burette. The air which goes in to replace the liquid in the large glass bottles should bubble through caustic potash solution in order to keep out carbon dioxide. Potash bulbs are used for this purpose.

The fact that phenolphthalin is sensitive to carbon dioxide in water solution and to carbonates and bicarbonates may lead to serious error unless sufficient care is taken to add enough acid to decompose all carbonates and bicarbonates and then expel the gas by boiling before subsequent titration with caustic potash. An illustration will make the matter clear. Let us suppose that in obtaining the relation between carbonate of soda and sulphuric acid in standardizing the acid, the carbon dioxide is not quite all removed by boiling, when we attempt to measure the excess of the acid by means of the caustic potash solution. We add this solution drop by drop and ultimately reach a point when all the free sulphuric acid is satisfied with the caustic potash, but since phenolphthalin in presence of carbonic acid or carbon dioxide in water solution does not change color until part at least of this carbonic acid is also satisfied with caustic potash, we do not get our end reaction when the sulphuric acid is all satisfied, as should be the case, but rather after some further addition of caustic potash. The error is obvious, and there is always uncertainty if carbon dioxide or carbonates are present when using phenolphthalin as indicator. Even carbon dioxide in the standard sulphuric acid solution, or carbonates in the caustic potash solution, will cause difficulty. Possibly other indicators do not give so much trouble from this cause, but all that we have ever tried are so much less sensitive and sharp at the end reaction than phenolphthalin, provided the conditions are right, that we prefer to take the extra trouble. Positive experiments show that if the solution is rendered clearly acid with standard acid, and boiled for 10 minutes or even less, the carbon dioxide will all be expelled, so that if the directions are closely followed, the results will be fairly accurate. It is obvious that if the distilled water used in making the standard acid contains carbon dioxide, there will always be some present, with a consequent liability to uncertainty in the final results. Presence or absence of carbon dioxide in the standard acid can be proved by titrating some of the acid cold with

standard caustic potash, using phenolphthalin as indicator and then titrating another similar portion after it has been boiled. If carbon dioxide is absent, the two tests should show the same figure. If it is present in injurious amount, it will be essential to always boil to expel carbon dioxide in all tests where this acid is used before attempting to titrate in presence of phenolphthalin.

It is well known that all indicators do not show the same end reaction, all other conditions being the same. If methyl-orange is used in standardizing the acid and alkali, the precautions in regard to carbonic acid may be ignored. If phenolphthalin has been used in standardizing the acid and alkali, it is essential, in order to use these solutions in this method, that the value of 50 c.c. of the standard acid should be obtained in terms of the standard potash, using methyl-orange as indicator, since, the indicator being changed, the ratio of acid and alkali will not be quite 1 to 1. Of course the value thus found should be used in the calculations as shown. Phenolphthalin is so much more sensitive than methyl-orange that it is recommended to standardize with the former, since it is quite essential to know pretty accurately the strength of the standard acid.

The reason for using methyl-orange as indicator is that phenolphthalin is unreliable in presence of ammonia salts.

Burettes may be satisfactorily calibrated by filling them with distilled water at temperature at which they were graduated, and then drawing out into a flask and weighing each 5 c.c. to the bottom, and then fill again and start 1 c.c. lower down, and proceed as before. Two or three times through in this way will check any discrepancies that will seriously affect the result. Of course, each 5 c.c. should increase the weight the same amount, and if the burettes are fairly well graduated the differences should not be over the weight of one drop, approximately 50 milligrams. Obviously by using a good balance and going through the burette times enough, the calibration can be made as fine as the graduation. It is hardly necessary to add that the burette used for acid during the standardizing, also the one used for potash during the standardizing, must always be so used, or if it is desired to use them interchangeably they must be exactly alike.

It is well known that change of temperature affects all volumetric work, and it is equally well known that there is no error from this cause if the solutions are used at the same temperatures at which they are standardized. Standard solutions may be kept on a shelf near the ceiling of the room where the temperature is about 80° F. They should be standardized finally after they have been at this temperature over night. With most of the determinations for which these solutions are used, a change of temperature of 10° F. does not introduce a greater error than would be produced by one drop of the solution. Of course, in very fine work care should be taken to use the solutions at the temperature at which they are accurate.

## AERIAL RAILWAYS.

The single-rope bridges of the Himalayas and the Thibetan frontier are probably one of the oldest and simplest engineering devices known. A rough rope, sometimes made only of twisted birch twigs, is fastened across the chasm of a mountain torrent, and round this is hung a hoop. In this the passenger sits, and hauls himself across by hitching the hoop forward as he holds the rope above with his hands. The only development of this primitive system was the addition of a second rope—an endless cord—by which the passenger in the hoop was drawn across from either side, with no more risk than was involved in the task of keeping himself from falling out of the hoop in which he sat. Some such rough form of transport, with buckets and wheels substituted for the hoop, was used for many years in the lead mines of the Peak of Derbyshire; but if hemp had remained the strongest material for rope-making, the aerial railway would never have taken the place which it has, or attracted the attention which it now claims, among the practical means of cheap transport.

The invention of the twisted steel rope has made the development of the aerial railway practically safe and commercially possible, and more than 2,000 miles of line are now in working order in Spain, Italy, South America, India, the Cape, China, and Japan. To "over-seas Englishmen" the cable-way at Hong Kong is as well known as the "Devil's Dike" Line will soon be to London visitors to Brighton. It shares with the latter the distinction of being the only aerial line used solely for passenger traffic, though it was built for useful and commercial reasons. It was found necessary to transport all European workmen in the port up the mountain every night, in order to sleep in purer air, and the cheapest and quickest means was found to be the construction of a "Telpher" line. The saving in time alone is said to have already repaid the cost of its construction. Nothing could be simpler than this Hong Kong line. It is carried straight up the mountain side, the endless line stretching from ravine to ravine, on high steel trestles, through which the little back-to-back cars run on the rope like a section of the "knife-board" of an old-fashioned omnibus. Three passengers sit on each side; and though the height at which they travel must be trying to the nerves, they are not shut in by aprons of steel wire, as in the case of the Brighton cars. An awning, for protection from the sun, is the sole addition to the minimum of accommodation provided on this airy journey. The length of the line is 2 miles, and the exact height ascended 1,090 ft. The Chinese population of Hong Kong were much disturbed by the invasion of the mountain by this railway. They attributed the epidemic of the plague to the anger of the mountain demons, who were prevented by the wires from making their nightly flights round the circuit of the hill.

The difficulties in the construction of the Table Mountain wire line were far greater than in that at Hong Kong. A precipice and incline of 800 ft. in height interrupted the ascent midway. The summit of this precipice was used as a support, and the suspending wire leaped in a single span of 1,470 ft. to the edge of the cliff, and from thence in another span of 1,400 ft. to the flat top of the mountain. The loads carried across these gulfs average half a ton each, and the line is used both for passenger and goods traffic. The rock of Gibraltar has also its wire line, though of slighter build, and far more striking steepness. The height to the signal station is barely a quarter less than the total length of the line, and the wire runs straight to the summit on a series of lofty trestles, after a first leap of 1,100 ft. in an ascent of 1 ft. in every 1¼ ft. Viewed against the sky, looking parallel to the mountain side, it looks like a telegraph wire stretched tight from the tops of a series of little Eiffel towers; yet the soldiers ascend and descend in the little wooden boxes which travel on it with equal safety and comfort. The Hong Kong, Gibraltar, and Table Mountain lines are worked on a double cable along which one car ascends as the other descends, the two being connected by a hauling rope.

But these are toys compared with the complicated and ever-increasing system of aerial trains now working in the great iron mines of Spain. Near Bilbao the greater part of a mountain side is quarried away at different levels to obtain the fine iron ore, which is carried to the railway by nine lines, running from the station at the foot of the mountain to the mines along the summit. These nine lines carry on an average 2,300 tons of ore a day, none of which touches the level of the ground till it has travelled some 5 miles through space. The appearance of these multiplex lines of wire stretching from tower to tower of light-trellised iron, and hung at intervals with hundreds of ore carriages in constant motion, is one of the strangest spectacles in modern mining enterprise. The double line of iron scaffolds, where it leaves the terminus in the valley, looks like the support for some enormous viaduct, festooned with wires slung with rows of pendent buckets. Higher up the mountain, where deep ravines cut the face of the hill, the trestles tower to such a height that the traveling loads of ore look like little black balls against the sky. When the different levels of the mine are reached, the lines of the wireway diverge, and are carried to nine separate points in the workings.

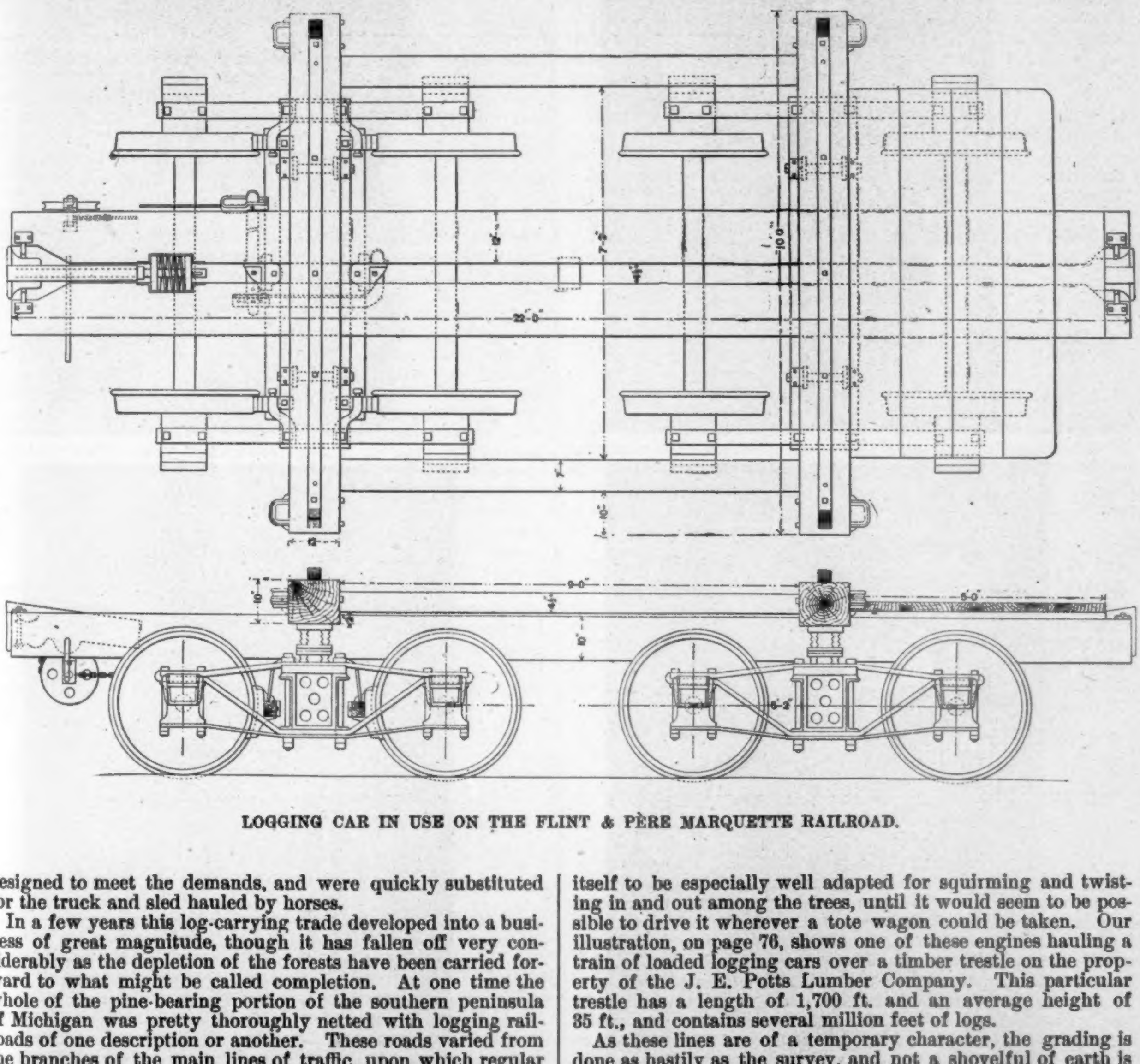
Yet the traffic is controlled with little difficulty, and there is no risk of any serious stoppage by accident, as in the case of a breakdown on the trunk lines of a great railway. At the worst, one or two lines only would be blocked, leaving the others free for use. It is calculated that 100,000 tons of ore can be carried on each of these cables before it becomes unfit for service. In crossing wide ravines or rivers where one bank is lower than another, the aerial line is used exactly as the old-fashioned funicular railway works, the descending load being used to haul up the ascending car. In the Alps, the Pyrenees, and in the bridging of deep river-beds, this is the simplest and cheapest form of transport known. In the Italian Alps a span of 1,500 yds. is crossed without a support, and this "gossamer" transport is soon to be applied to distances of 2,000 yds. The usual means of drawing the load on level lines where it is not carried by the force of gravity is to revolve the endless cord by a drum worked by steam. But a recent and ingenious invention promises a further development of aerial lines. The steel rope is charged with an electric current, and the cars themselves carry a motor which "picks up" its power as it travels along the wire.—*London Spectator.*

CRIB TRESTLE ON THE LOGGING RAILROAD ON THE PROPERTY OF THE J. E. POTTS LUMBER CO.

## LOGGING RAILROADS.

WHEN the pineries of the Northwest were standing in all of their primitive grandeur and extent, the work of their devastation was naturally carried on close to the banks of the rivers and streams that afforded an easy and natural highway for the transportation of the logs to the mills, where it was to be sawn; but the day came when the timber had been cut off to such a distance back from the streams that it became difficult to obtain a sufficient supply to meet the demands of the mills that were in operation along the lakes and in the river towns. Therefore, if these mills were to be kept running at the rate of which their machinery was capable, the material must, of necessity, be brought from points further inland. To do this with horses was a work of such magnitude that it could not even be considered, so the logging road was developed, and locomotives and cars of special construction were designed to meet the demands, and were quickly substituted for the truck and sled hauled by horses.

In a few years this log-carrying trade developed into a business of great magnitude, though it has fallen off very considerably as the depletion of the forests have been carried forward to what might be called completion. At one time the whole of the pine-bearing portion of the southern peninsula of Michigan was pretty thoroughly netted with logging railroads of one description or another. These roads varied from the branches of the main lines of traffic, upon which regular trains were run for passengers and miscellaneous freight, or through the several grades of branches, spurs, private lines and mill sidings. The larger branches presented no novel or peculiar features, and were usually constructed with a view to a permanence that would in the future be suitable for regular railroad work. Starting out from the branches at such intervals as the convenience of the property owners might indicate were a number of spurs of 1, 2 or 3 miles in length, and intended for the special use of these owners. They were usually surveyed and graded at the expense of the firm owning the standing timber, while the rails were laid by the railroad to which the spur was tributary. These surveys were necessarily made with haste, as the idea was not so much to select the best as a possible location. The usual method that was pursued was for the company's engineer to go over the ground, and in a hasty manner select the general course of the road, and at the same time gather a tolerably correct idea of the topography of the country. A sketch of the desired line would then be laid down on the section map, and a preliminary line run and the levels taken; then, if the result came within the prescribed limits of grades, curves and excavations, the work would be handed over to the contractor. If the spur were to be tributary and the logs were to be sent over the main line, the grades would be limited to 200 ft. to the mile, and the curves to 12°; but if the line is operated by engines belonging to the owners of the property, and the cars are the open rack logging cars, these curves and grades are greatly exceeded. We have seen cases where the grades have risen to as much as 290 ft. to the mile, and the curves to 18°. In such cases as this the Shaw locomotive is usually employed, and this machine, with its flexible wheel-base, has shown itself to be especially well adapted for squirming and twisting in and out among the trees, until it would seem to be possible to drive it wherever a tote wagon could be taken. Our illustration, on page 76, shows one of these engines hauling a train of loaded logging cars over a timber trestle on the property of the J. E. Potts Lumber Company. This particular trestle has a length of 1,700 ft. and an average height of 35 ft., and contains several million feet of logs.




LOGGING CAR IN USE ON THE FLINT & PÈRE MARQUETTE RAILROAD.

As these lines are of a temporary character, the grading is done as hastily as the survey, and not a shovelful of earth is moved that the necessities of the case do not demand. The fills are rarely more than 10 ft., and we have never seen them more than 12 ft. wide, while the cuts are from 12 ft. to 14 ft. wide, with banks as steep as they will stand. Not a stump is pulled or a tree cut down that is not actually in the way, and such things have been known as a cut of from 6 ft. to 8 ft. in depth, with banks rising two in one, and a pine-tree 100 ft. high standing on the very edge, with the roots half cut away to allow the cars to pass. On such a road ballast is supplied only as far as it is actually required to hold the ties in place, and it is somewhat odd to see a heavy locomotive working its way over such a road, where in places the branches of the trees meet overhead. While collisions are not to be feared,

FIG. 9.

FIG. 10.

FIG. 11

FIG. 12.

VIEWS DURING CONSTRUCTION ON THE WESTERN SIBERIAN RAILWAY.

the operation of these roads is a matter that requires the utmost care on the part of the trainmen, especially in the winter. The grades are steep, the track curved and uneven, and with a load of from 20 to 25 heavily loaded flat cars, piled with logs and perhaps covered with ice and snow, and ready to slide from their places on the slightest provocation, the engineer has to use all of his skill to get out to the main line. In what has been said we do not wish to convey the idea that the work of construction is not substantially done; it is merely cheaply done, for the operators do not have to regard the matter of future cost of operation, since the rails will be torn up and used elsewhere as soon as the timber is cut, and where the roads are worked by private concerns the cost of fuel is an item of no account, as the engine will burn the refuse of the mill.

Frequently the roads will be surveyed and built by the foreman of the mill, with no other instruments than a tape-line and a few axes and shovels. Such work as this is, however, the exception, and is apt to result in bent rails to such an extent that there will be no economy in the long run.

The railroad companies that have catered to the logging trade have not departed from the ordinary standards of locomotive construction, and have found the mogul to be the most serviceable for the work. The cars, on the other hand, have been especially designed for the traffic. At first the regular flat car was employed, but it was found to be too high for convenient loading, and the brake staffs were in the way. They were bent and twisted by the logs in the loading, and frequently so hedged in that the trainmen were unable to get at them when brakes were called for. The first change that was made was that of lowering the sills and running the draft-rigging in through the end sill. At the same time the brake-staffs were done away with, and the brakes were applied by means of a chain rove over a wheel beneath the floor and caught by a dog when it was pulled up. It was very rarely that these chains were inaccessible, and this method of applying the brakes has proven reliable and satisfactory.

These modified cars were of the regular length of about 34 ft., and on them two tiers of logs of 16 ft. lengths were loaded. This was not entirely satisfactory, and the car illustrated on page 77 was designed for the work. It is the car that is now in use on the Flint & Père Marquette Railroad. It is a substantially built, open framework, resting on bogie trucks that are 9 ft. between centres. The whole framing of the car consists of two heavy bolsters of 10 in. × 12 in. timbers, held together by four sills. The outside sills are 4½ in. × 7 in., and the centre sills are 10 in. × 12 in. These latter extend out to the ends of the car, and serve as dead woods as well as for the attachments of the draft-rigging. The bolsters are protected by an iron plate from the wear of the logs, and at each end there is a stake pocket. The standard trucks are used with the usual brake attachments. These cars are not only less expensive in their first cost, but are lighter and more easily handled in the woods than the flat cars, and will probably hold their own until the forests entirely disappear, which does not seem now to be a matter of the remote future.

## RUSSIAN ENGINEERING NOTES.

### LAUNCH OF NEW RUSSIAN ARMORED SHIPS.

On November 7, 1894, a new Russian armored battleship, the *Poltava*, was launched from the yard of the New Admiralty in St. Petersburg.

The dimensions of the armored ship *Poltava* are less than those of the armored ship of the Black Sea fleet, the *Tri Swiatitela*. The extreme length is 375 ft.; breadth, 70 ft.; displacement, 10,960 tons. The propeller consists of two screws cast from aluminium bronze. The triple-expansion engines furnish 10,600 I.H.P. The speed of the ship will not be less than 17 knots. The ship is protected with armor plates 16 in. thick amidships, and about 8 in. at the bow and stern. The total weight of the armor is 2,848 tons, or 26 per cent. of the whole displacement. At present the launched hull weighs only 4,600 tons, or 42 per cent. of its displacement.

The armament of the ship will consist of four 12 in. guns, eight 8 in. guns, ten 1-lb. and fifteen 5-lb. Hotchkiss guns, and two Baranov guns. The ship is covered with an armored deck and carries two turrets, each with two 12-in. guns.

The torpedo armament consists of 6 submarine apparatus and 50 sphero-conic torpedoes, in addition to which there is a set of protecting nets.

The keel was laid March 9, 1892. The whole hull is made of Russian materials and by Russian engineers and workmen. The engine was ordered in England from the firm of Messrs. Gumfreis, Tennant & Company, which delayed the execution of order six months.

On November 9, 1894, a new Russian armored battleship, the *Petropavlovsk*, was launched from the slip of Galerny Isle, in St. Petersburg. The dimensions and construction of the ship are the same as of the armored ship *Poltava*, launched a few weeks later from the slip of the New Admiralty in St. Petersburg. Both were dedicated by the late Emperor Alexander III. on May 7, 1892. Only one battleship of those designed now remains on the stocks—viz., the *Sebastopol*. She is being constructed at Galerny Isle, St. Petersburg, and will be launched next spring.

In the past year four Russian armored ships were launched: the *Admiral Seniavin*, *Sysoi the Great*, *Poltava* and *Petropavlovsk*.

In the New Admiralty, in St. Petersburg, the construction of a new coast-defence armored ship, the *General-Admiral Count Apraxin*, has been commenced; and at the yard of Galerny Isle, St. Petersburg, the construction of a high-speed ocean cruiser is also projected. This cruiser will be of the same type as the cruiser *Russia*, with three screws, now in construction at the Baltic Works.

Besides these in the New Admiralty yard the construction of an armored battleship of the type of the *Sysoi the Great* is projected.

In the spring of 1895 a series of launches is expected, and the Russian fleet will be increased by a number of new gigantic ships.

The *Petropavlovsk* is named from Port Petropavlovsk, in Kamchatka, on the Pacific.

## VIEWS ON THE WESTERN SIBERIAN RAILWAY.

On the opposite page another series of four views, from the interesting photographs received from our correspondent in Siberia, are given, showing the progress of this great work.

Fig. 9 shows an ordinary piece of earthwork.

Figs. 10 and 11, earthwork in cutting a new channel for the Tabol River near Kourkan.

Fig. 12, track-laying.

These views give some idea of the character of the country through which this road is built; and the portion shown in these and others indicate that it resembles very much that of our Western prairies. They also show the force of men which has been and probably still is employed in carrying this new line across the continent of Asia. What its influence will be on both European and Asiatic polity and civilization when completed no one can even vaguely predict.

## THE HISTORY OF THE FOUR-WHEELED "BOGIE" ENGINE.

The following interesting history of the "bogie" engine has appeared in the *English Mechanic*, and is from the pen of Mr. Clement E. Stretton, C.E., and will interest many of our readers:

"There are few subjects connected with the history of the locomotive engine which have at various times engaged more attention, or have caused so much acrimonious discussion, than the history of the 'bogie engine,' and more especially the question as to whether the credit for its introduction belongs to England or to America.

"The writer, viewing the matter simply from the position of an impartial, independent historian, has not accepted the claims or statements of either side, but has fully investigated the whole of the reliable evidence and official records with the following results.

"As early as the year 1800 the Merthyr-Tydfil tramroad was opened in South Wales, and in order to convey long bars of iron, and also timber, wagons were constructed in pairs coupled together by an iron drawbar having a joint at either end. These wagons had no sides, but in the middle of each there was fixed a centre pin upon which worked a cross-beam or 'bolster,' upon which the timber or bars of iron were placed. Of course, it will be at once seen that these early

wagons were not actually 'bogie' vehicles, and that they were in use before even the first locomotive engine had ever run upon rails; yet we cannot upon examination fail to see that they contained all the essential principles of the 'bogie.' They allowed a very long load to be conveyed round sharp curves, and permitted the wheels under the two trucks to follow the curve of the rails. Now, the most improved 'bogie' vehicles of to-day simply carry out the very same principle. There can be no question as to the practical value of these early 'bogie' wagons, when it is mentioned that some of them were in use from 1800 to 1875, and that two of them were sent from South Wales to the Chicago Exhibition of 1893.

"In 1813 Blackett & Hedley constructed two engines for working on the Wylam Colliery Line, near Newcastle-on-Tyne. The first of these was named *Puffing Billy*, the second *Wylam Dilly;* they both ran upon four wheels and were successful so far as conveying coal cheaper than by H.P.; but their weight broke the cast-iron plate rails to such an extent that it became necessary to carry half-a-dozen rails upon each engine, to replace those which might be broken during the journey. To prevent the breaking of the rails Blackett & Hedley placed each engine upon eight wheels, arranged exactly like the Merthyr-Tydfil timber wagons. They put the wheels under two separate frames or trucks; in other words, they placed their engines upon two four-wheeled 'bogies' in the year 1815. These two double 'bogie' engines worked successfully from 1815 to 1830, when the railway was relaid with stronger rails; flanged wheels were employed, and the engines were again returned to four wheels; and one of the engines is now preserved at South Kensington Museum, and the second at the Edinburgh Museum.

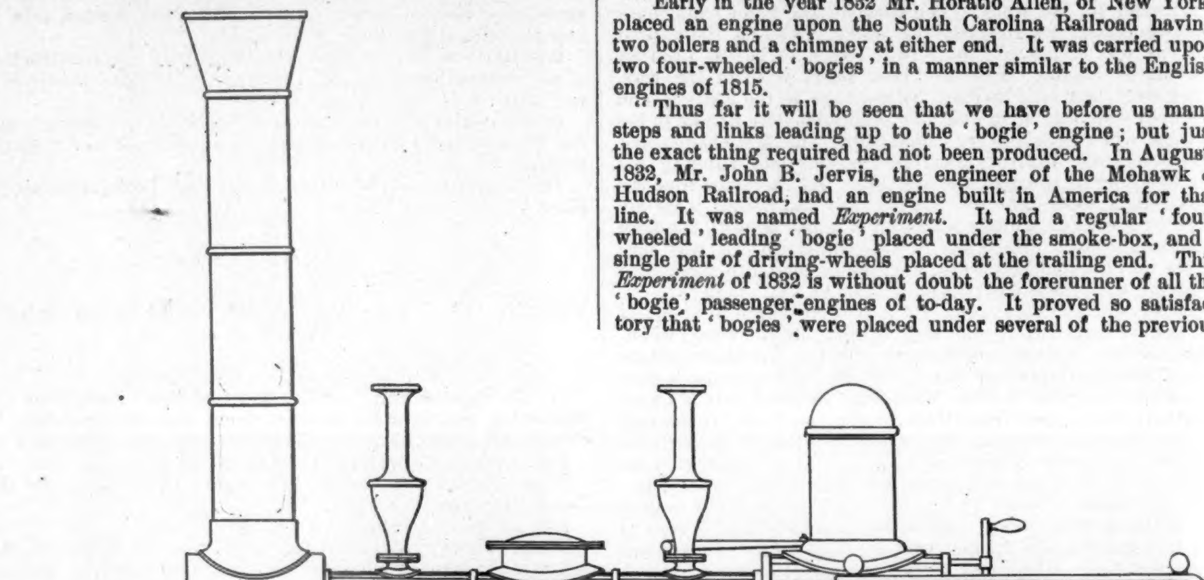
"Now here we have ample proof that two engines, each having two four-wheeled 'bogies,' were actually at work in England for 15 years, *before* 1830, and before any 'bogie' engine had been tried in America or other part of the world. On the other hand, it will be seen that the English abandoned the use of the 'bogies' on these engines in 1830, and therefore that they either did not observe or did not appreciate the value of the 'bogie,' for it will be found that the celebrated *Rocket*, *Planet*, and other engines of the period had the rigid wheel-base.

"During the year 1831 Messrs. Stephenson & Co. sent out four engines to America, named *Whistler*, *Delaware*, *John Bull* and *Stevens*, which had its name changed to *John Bull*. Mr. Bury, of Liverpool, also sent his well-known *Liverpool* of 1831; but experience quickly proved that the American railways were not so strongly laid as were those in England, for engines which were satisfactory in this country were in the United States found too heavy, or had difficulty in passing round very sharp curves. The engine *Stevens*, *John Bull*, running upon the Camden & Amboy Railroad, was within a few weeks of its arrival fitted by the Americans with an extra pair of wheels in front, attached to a swivelling frame—in other words, a two-wheeled pony truck; and it is a matter of much interest that this old engine has been so well preserved in working order, that at the commencement of the Exhibition of 1893 it ran in steam with its train from New York to Chicago, a distance of 913 miles—a remarkably good performance for an engine 62 years of age.

"Early in the year 1832 Mr. Horatio Allen, of New York, placed an engine upon the South Carolina Railroad having two boilers and a chimney at either end. It was carried upon two four-wheeled 'bogies' in a manner similar to the English engines of 1815.

"Thus far it will be seen that we have before us many steps and links leading up to the 'bogie' engine; but just the exact thing required had not been produced. In August, 1832, Mr. John B. Jervis, the engineer of the Mohawk & Hudson Railroad, had an engine built in America for that line. It was named *Experiment*. It had a regular 'four-wheeled' leading 'bogie' placed under the smoke-box, and a single pair of driving-wheels placed at the trailing end. This *Experiment* of 1832 is without doubt the forerunner of all the 'bogie' passenger engines of to-day. It proved so satisfactory that 'bogies' were placed under several of the previous four-wheeled engines, and the 'bogie' (or, as the Americans always call it, the truck) has ever since been adopted and used in the United States. In 1833 Messrs. Stephenson & Co. constructed an engine named *Davy Crocket* for the Saratoga & Schenectady Railroad. This engine had a leading 'bogie' and single driving-wheels, and was almost exactly similar to the *Experiment* of Mr. Jervis. Some persons have stated and claimed that the English *Davy Crocket* was built to the order and design of Mr. Jervis; others have maintained that it was designed at Newcastle. This point, it will be seen, is of practically no importance in the chain of history, for when it is proved that the first engine of the class was built in 1832, it matters but little who built an almost exact copy of it about a year later.

"During the time that Stephenson was building the *Davy*




THE LOCOMOTIVE "DAVY CROCKET," BUILT BY R. STEPHENSON IN 1833 FOR THE SARATOGA & SCHENECTADY RAILROAD.

*Crocket* and some other *leading* 'bogie,' engines for America, Messrs. Carmichael & Co., of Dundee, were busy constructing three engines for the Dundee & Newtyle Railway in Scotland. These engines had a single pair of driving-wheels placed in front, and a four-wheeled 'bogie' at the trailing end. The first of these engines was named the *Earl of Airlie*, and was put to work in September, 1833. These three locomotives were consequently the only ones working in Great Britain with a 'bogie.'

"When the Birmingham & Gloucester Railway was opened it was found that no English engines could run up the Lickey incline of 1 in 37. Eight American engines were therefore supplied, in 1840, by Norris & Co., of Philadelphia. They all had the leading 'bogie' and a single pair of driving-wheels, and were then the only *leading* 'bogie' engines in this country.

"Until the year 1874 it may be said that the 'bogie,' either for engines or carriages, found very little favor in this country; but in that year the introduction of American Pullman-car trains upon the Midland Railway proved to all impartial persons that 'bogie' coaches ran far more steadily than either four or six-wheeled English vehicles.

"About the year 1876 several of the English railways constructed express engines with leading 'bogies,' and this pattern has gradually become more and more popular and successful, until now it may be said that the 'bogie' has been adopted by nearly every line of importance in Great Britain except the London & Northwestern.

"From the particulars above given, it will be apparent that the 'bogie' had its origin in England, but that its general adoption for passenger engines commenced in America in 1832, and that between the years 1876 and the present time the 'bogie' has been brought back, so to speak, to this country, and now it is easy to see that very few more passenger engines will be built in Great Britain without a 'bogie.'

"CLEMENT E. STRETTON, C.E.

"LEICESTER, December 13."

Mr. Stretton, as the readers of THE AMERICAN ENGINEER are aware, has been an indefatigable investigator into the history of the locomotive, and it has been through his efforts that much that has been interesting has been rescued from oblivion. In his excellent book on the "Locomotive Engine and its Development," he has given an engraving of the *Puffing Billy*, which it is said Hedley placed on two four-wheeled trucks in 1815. This illustration has been published often heretofore, but it does not seem entirely certain from the engraving that the two groups of four wheels, at each end of the engine, could move about a centre pin as an ordinary truck does. It has often been stated that they did, but from the engraving alone it is thought there is equally as good evidence for inferring that they did not. It is hoped that Mr. Stretton may be able to obtain some more conclusive evidence with reference to this point than has thus far been quoted.

That the invention of the "bogie" or truck was almost contemporaneous with that of railroads themselves has often been shown, and the discussion of the question, whether it originated on this or the other side of the Atlantic, is a matter of not very much importance. That the "bogie" system would suggest itself wherever four-wheeled cars were used without any invention is obvious, and that it was evolved in that way in the early days of railroading, both in England and in this country, has often been shown. In the celebrated Winans eight-wheeled car case it was proved that "bogie" cars had been used on the Quincy Granite Railroad in Massachusetts as early as 1829, and that in the early days of the Baltimore & Ohio Railroad it was a common practice to load fire-wood on two four-wheeled cars by placing a bolster on each, connected to the car by a centre pin, and then adding long timbers attached to each of the bolsters. The fire-wood was then laid crosswise on the timbers. An English patent granted to W. and E. W. Chapman in 1812. The specification was published in the 24th volume of the Repertory or Repository of Arts, etc., in February, 1814, with drawings. The latter shows a carriage of six wheels for the engine, which the patentees say "may rest equally, or nearly so, on each of its wheels, and move freely round the curves or past the angles of a railway; the fore pair of wheels are, as usual on railways, fixed to the body of the carriage, and the other two pair are fixed on axles (parallel to each other) to a separate frame, over which the body of the carriage should be so poised as that two-thirds of its weight should lie over the central point of the fore wheels where the (pivot ?) 4 is placed, and the remaining third over the axis [axle] 1, 1. The two-thirds weight of the carriage should rest on conical wheels or rollers bearing upon curved plates, so as to admit the ledges of the wheels or those of the way to guide them on its curves or past its angles, by forcing the transom or frame to turn on the pivot, and thus arrange the wheels to the course of the way, similarly to the carriage of a coal wagon;" and the patentees add, "If the weight of the locomotive engine should require eight wheels, it is only requisite to substitute, in place of the axis [axle], a transom such as described, laying the weight equally upon both, and then similarly to two coal wagons attached together, the whole four pair of wheels will arrange themselves to the curves of the railway."

In the same trial it was shown that the drawings for the eight-wheeled, double-truck locomotives, designed by Mr. Horatio Allen, and built for the South Carolina Railroad, were made in 1830 and 1831, and the engines were put in operation in 1832. Mr. Jervis testified that in the latter part of the year 1831 he invented a new plan of frame, with a bearing carriage for a locomotive engine, and that an engine was constructed on this plan in 1832. It will be seen that Mr. Stretton states that in 1833 Messrs. Stephenson & Co. constructed an engine named the *Davy Crocket* for the Saratoga & Schenectady Railroad. A blue print from a drawing of this engine has been received from him, and is reproduced herewith. It would be interesting to know whether the plan of this engine was adopted on the suggestion of Mr. Jervis, or whether, as has been claimed, it was designed in Newcastle.

Mr. Stretton has given us a very interesting *résumé* of this history, which has been the subject of a good deal of warm discussion.

## REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK.

ADVANCED copies of the report of this Commission for the year 1894 have been received. Of the

GENERAL SITUATION

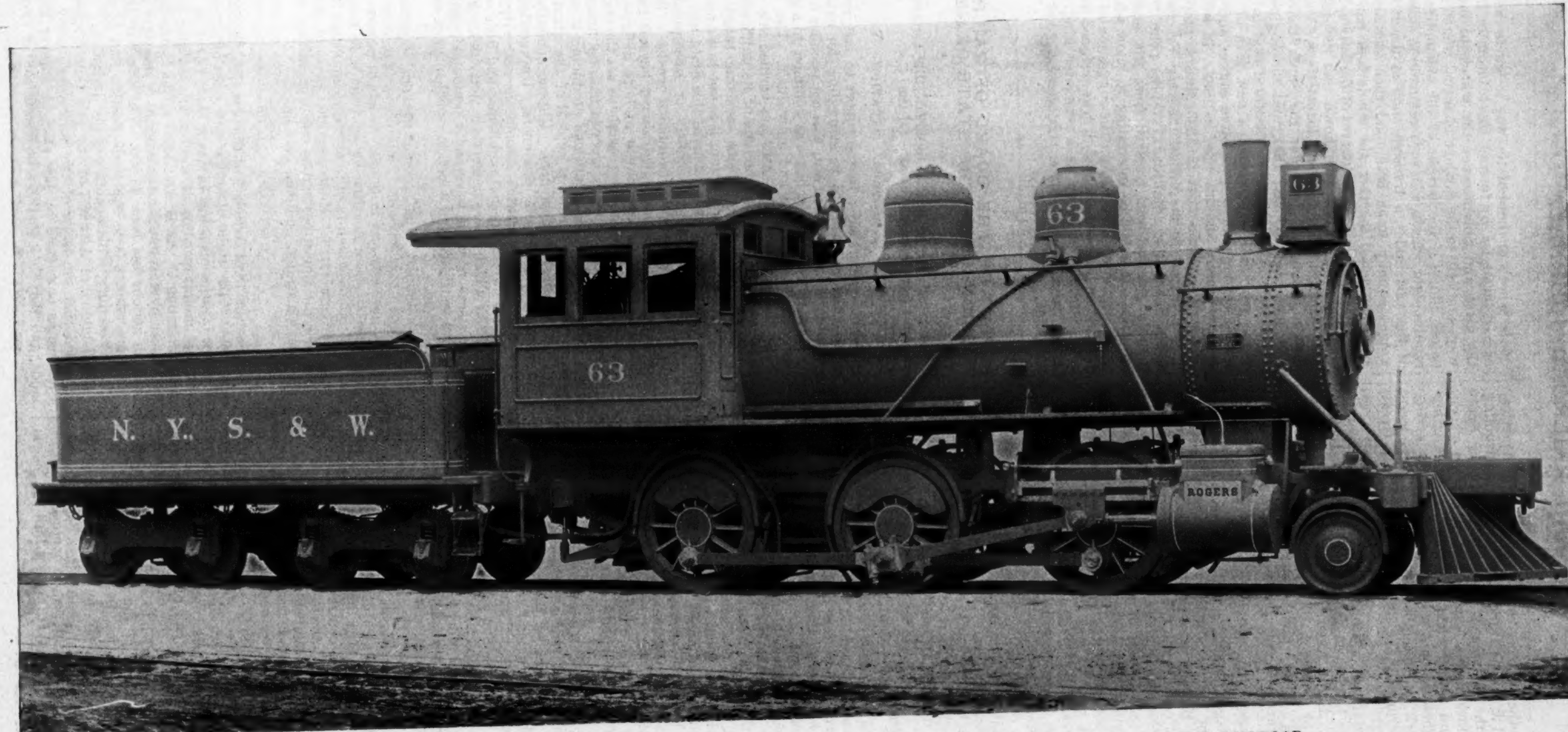
the commissioners say: In the report of last year the Board declared the railroads to be struggling for existence. This condition, it was pointed out, was not peculiar to them nor to any class of enterprises, but was common to a great mass of associations, institutions and individuals. The business history of the past twelve months has verified this view beyond the belief of the Board at the time of its publication. During that period, excluding persons receiving salaries, wages, or similar forms of remuneration, it is not to be questioned that the vast majority of the citizens of this State, and of the whole Union, has subsisted, consciously or unconsciously, out of capital or of previously accumulated wealth. The income of the people has been curtailed almost beyond precedent. It has been a period of expedients, of hope deferred and of protracted trial. It is not yet possible to see the end. The continuous recurrence of a deficiency in national finances, with no sure promise that the conditions producing it are to be reversed in the near future, is typical of the situation in many quarters of the business field. Unprecedentedly low prices discourage and cripple producers. Unprecedentedly small shipments from producers discourage and cripple carriers. Manufacturers, traders and middlemen find little or no margin of profit on which to exercise their activities. The pressure of such a season, when too greatly prolonged, deadens the co-operative spirit, without which the mechanism of society ceases to be efficient.

The community thus becomes nervous, impatient, destructive, tending to resolve itself into discordant units rather than to act in harmony and in union. Gusts of passion, vociferous utterances of false doctrine sweep from their moorings thousands of minds which in ordinary days could not thus be controlled or captivated. Hence, in other parts of the Union we have seen the almost portentous rise of a political organization professing a strange and demented creed.

CONSTITUTIONAL CHANGES.

By Section 18 of Article 1 of the new Constitution, it is provided that "the right of action now existing to recover damages for injuries resulting in death shall never be abrogated, and the amount recoverable shall not be subject to any statutory limitation." As is well known, the limitation imposed heretofore by statute upon the amount of damages recoverable in such actions has been $5,000. The effect of the constitutional amendment is to supersede Section 1904 of the Code of Civil Procedure, which contained the limitation.

By Section 7 of Article 7 of the new Constitution, it is also provided that the lands of the State constituting the Forest Preserve as now fixed by law shall be forever kept as wild lands, and that they shall not be leased, sold or exchanged, or




MOGUL LOCOMOTIVE, BUILT BY THE ROGERS LOCOMOTIVE CO. FOR THE NEW YORK, SUSQUEHANNA & WESTERN RAILROAD.

be taken by any corporation, public or private. This will, in effect, hereafter prohibit the construction of railroads thereon.

ACCIDENTS.

The table of accidents for the year ending June 30, 1894, shows a slight decrease in their number as compared with the report for 1893. Seven hundred and twenty-three persons were killed and 1,821 injured, as compared with 742 killed and 2,288 injured in 1893.

The number of passengers killed from causes beyond their own control was 29; and injured, 142. Many of the injuries to passengers were but slight, such as being cut by glass, bruised, etc. Fourteen passengers were killed and 62 injured by getting on or off of trains in motion. In this volume are included the reports of investigations by the Board of all of these accidents not referred to in the report of 1893.

The number of employés killed in 1894 was 185, and the number injured 1,166, as compared with 306 killed and 1,622 injured for the year ending June 30, 1893. The equipment of freight cars with automatic air brakes and couplers undoubtedly accounts for some of this decrease, but the primary cause was the decreased number of employés, owing to decreased business.

TRESPASSERS.

Two hundred and twenty-seven trespassers on railroad tracks were killed during the year and 155 injured, compared deaths and injuries of trespassers and the diminution of the casualties to employés.

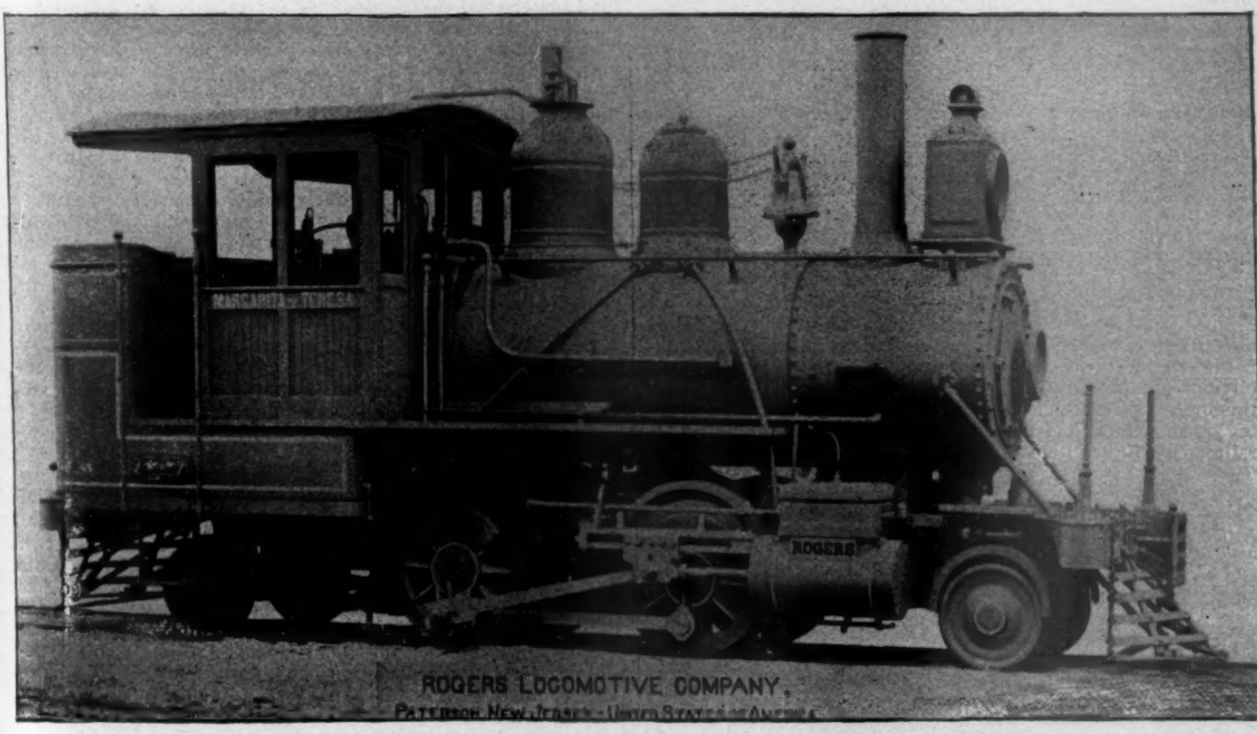
GUARD-RAILS AND FROGS.

Two persons have been killed and 9 injured during the past year by having feet caught in guard-rails or frogs, as compared with 11 killed and 18 injured during the year 1893. The railroad companies are observing the recommendations of this Board in regard to blocking frogs and guard-rails. This is an especially gratifying result, as the victims of this sort of accident are, without exception, employés of the companies, and it is impossible for them to protect themselves against the peril of the frog that is not blocked.

SAFETY APPLIANCES.

The Board renews its recommendations of last year in regard to the advisability of equipping passenger cars on other than single-track railroads with platform gates, and locomotive engines with a muffler for the safety-valve, and a device to protect the check-valve in case of collision.

The tendency to increased weight of rail is noted by the action of the New York Central & Hudson River Railroad Company in laying some 70 miles of 100 lb. rails on its Hudson River Division, its purpose being to relay the whole of this division with this rail.




DOUBLE-ENDER PLANTATION LOCOMOTIVE, BUILT BY THE ROGERS LOCOMOTIVE CO.

with 197 killed and 113 injured during the year 1893. This increase may be accounted for by the increase in the number of miscellaneous floating characters or tramps whose lives are spent on freight trains or in walking between stations.

AUTOMATIC COUPLERS AND AIR-BRAKES.

Gratifying progress is being made by the various roads of the State under chapters 543 and 544 of the Laws of 1893, in regard to the equipment of freight cars with automatic couplers and air-brakes. From what the Board can ascertain as to results in other States under the act of Congress in regard to this subject, and from a perusal of the latest reports of the Interstate Commerce Commission, it is justified in expressing the belief that the equipment of this State is in advance of that of the rest of the Union. This view is decidedly confirmed by the fact that accidents to employés in the remainder of the Union seem to increase rather than to diminish, while in this State they have diminished. It is further confirmed by the contrast exhibited in this State between the increase of the

## NEW LOCOMOTIVES FROM THE ROGERS LOCOMOTIVE WORKS.

The Rogers Locomotive Company, of Paterson, N. J., have recently completed the construction of two locomotives, engravings of which we present on this and the opposite page. One was built for the New York, Susquehanna & Western Railroad, and the other for a Cuban plantation railway. The following is a list of the principal dimensions of these engines:

LEADING DIMENSIONS OF MOGUL ENGINE NO. 63, FOR NEW YORK, SUSQUEHANNA & WESTERN RAILROAD COMPANY.

| | |
|---|---|
| Gauge | 4 ft. 9 in. |
| Fuel | Anthracite coal. |
| Total wheel base of engine | 22 ft. 2 in. |
| Driving-wheel base | 14 ft. 6 in. |
| Weight of engine in working order | 127,000 lbs. |
| " on drivers " " " | 110,000 lbs. |
| " " truck " " " | 17,000 lbs. |
| Diameter of cylinders | 19 in. |
| Length of stroke | 26 in. |

| | |
|---|---|
| Diameter of driving-wheels | 54 in. |
| " " truck-wheels | 33 in. |
| Type of boiler | Straight. |
| Diameter of boiler at front ring | 66 in. |
| Length of firebox | 131¾ in. |
| Width " " at grate | 33 in. |
| Number of tubes | 259 |
| Diameter of tubes | 2 in. |
| Length " " | 11 ft. |
| Heating surface, firebox | 197 sq. ft. |
| " " tubes | 1,483 sq. ft. |
| Total | 1,680 sq. ft. |
| Grate area | 30.2 sq. ft. |
| Boiler pressure per sq. in | 180 lbs. |
| Tender frame | 9 in. channels. |
| " trucks | Fox-pressed steel. |
| Tank capacity, water | 3,500 galls. |
| " " coal | 8 tons. |

LEADING DIMENSIONS OF DOUBLE-ENDER PLANTATION ENGINE "MARGARITA Y TERESA."

| | |
|---|---|
| Gauge | 4 ft. 8½ in. |
| Fuel | Bituminous coal. |
| Total wheel base | 18 ft. 6 in. |
| Driving-wheel base | 5 ft. 6 in. |
| Weight in working order | 68,000 lbs. |
| " on drivers | 38,000 lbs. |
| " " front truck | 14,000 lbs. |
| " " back " | 16,000 lbs. |
| Diameter of cylinders | 13 in. |
| Length of stroke | 22 in. |
| Diameter of driving-wheels | 40 in. |
| " " truck-wheels | 26 in. |
| Type of boiler | Belpaire. |
| Diameter of boiler at front ring | 50 in. |
| Length of fire-box | 40¼ in. |
| Width " " at grate | 34¼ in. |
| Number of tubes | 167 |
| Diameter of tubes | 1¾ in. |
| Length of tubes | 8 in. |
| Heating surface, fire-box | 54 sq. ft. |
| " " tubes | 611 sq. ft. |
| Heating surface, total | 665 sq. ft. |
| Grate area | 9. 6 sq. ft. |
| Boiler pressure | 160 lbs. |
| Tank capacity, water | 850 galls. |
| " " coal | ½ ton. |

## THE EMPLOYMENT OF FIREMEN ON RAILROADS.

THERE has been a great deal written about the method of selecting the firemen who are employed on railroads. As the future engineers are generally promoted from the firemen, it is obviously important that good material should be selected for this branch of railroad service. In this connection the following form, which has been adopted on one of our principal railroads, will be interesting to many of our readers:

(FACE OF SHEET.)

APPLICATION FOR EMPLOYMENT OF FIREMEN.

*All applications for employment as firemen must be made upon this form and filled up with ink in the handwriting of the applicant, giving Christian and surname in full, together with age and residence.*

| | | | | |
|---|---|---|---|---|
| Name.<br>Age.<br>Residence. | | | | |
| State names of all other railroads on which you have been employed, and in what capacities. | | | | |
| State present occupation, if any; if not, state where last employed, and give reasons for leaving last situation. | | | | |
| Have you ever been employed in the service of this Company? If so, where, and in what capacity? | | | | |
| Give an example in each of the four fundamental principles of arithmetic as shown in the four right-hand columns. | Addition. | Subtraction. | Multiplication. | Long Division. |
| Give names and residences of at least two responsible and well-known persons who will vouch for your good character—preferably your former employers. | | | | |

In case I am employed, I agree to abide by and be governed by the rules of the Company, to abstain from the use of intoxicating liquors, and pay my obligations without annoyance to the Company; to keep the engine or engines to which I may be assigned clean and neat; to be careful in the use of fuel, and protect the Company's property as far as lies in my power.

(Signature of applicant)

.......................................

Date..........................

(Over)

(BACK OF SHEET.)

Application of

.......................................

For employment as

.......................................

.......................................189-

Approved

.......................................Supt.

Applicant Employed

.......................................189-

.......................................
Master Mechanic.

.......................................
Station.

RULES GOVERNING THE EMPLOYMENT OF LOCOMOTIVE FIREMEN.

In the selection of men for the position of locomotive firemen, the following rules will be observed:

1. All applications must be filled out with ink in the handwriting of the applicant, who will give his Christian and surname in full, age and residence.

2. Where they possess the necessary qualifications, preference will be given to employés such as helpers, wipers, hostlers, machinists, brakemen and trackmen, whose employment has made them somewhat familiar with an engine.

3. All applicants must be able to read and to write legibly, and understand mathematics as far as addition, subtraction, multiplication and division, and to be not less than twenty-one nor more than twenty-eight years of age.

4. All applicants will be required to furnish recommendations from two (2) responsible and well-known persons as to honesty, sobriety and character in general.

5. All applicants will be required to learn the duties of the position without compensation before they are assigned to duty.

6. All applicants will be required to pass a satisfactory physical examination as to their ability to perform the duties of a fireman; also as to hearing and sight and ability to distinguish colors, as required by the rules of the company.

7. Firemen will be required to abstain from the use of all intoxicating liquors, and to pay their obligations without annoyance to the company.

NOTE.—All applications for employment as firemen must be made to the master mechanics of the respective divisions, who will forward same to their respective superintendents for approval, and return for file in the office of the master mechanic.

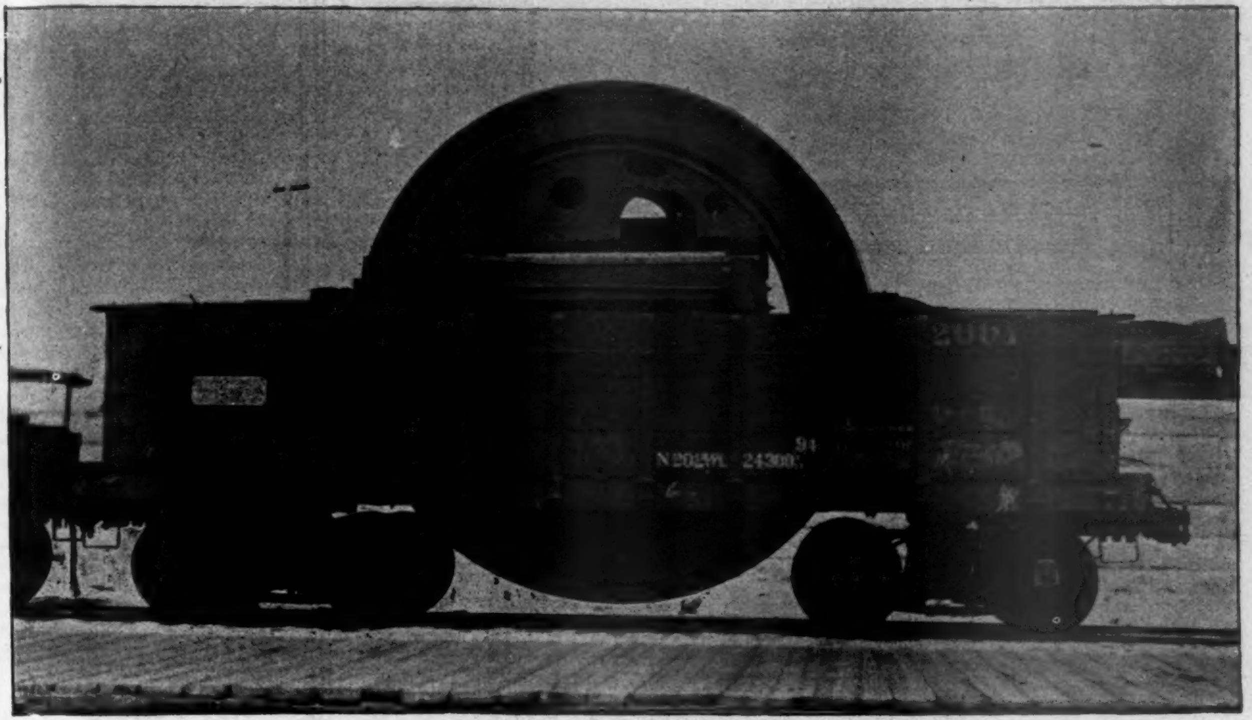
## A SHIPMENT OF MORTAR CARRIAGES.

THE construction of heavy ordnance and the necessity of shipping it from the points of manufacture and testing to its final position in the fortifications for which it is intended has necessitated some radical changes in the cars that are used for this purpose. When the great Krupp gun was sent to the Columbian Exhibition the Pennsylvania Railroad built a special car for its transportation, which was illustrated and described in our issue for May, 1893. In the illustrations on page 85 we show the method that was adopted for the shipment of the heavy mortar carriages from Sandy Hook to San Francisco. There were 12 of the carriages to be shipped, each weighing about 33 gross tons. They are intended for the 12-in. breech-loading mortars to be planted in the fortifications of San Francisco Harbor. The largest pieces in the carriages are the upper and lower roller paths on which the carriage proper rests. These paths are 14 ft. in diameter and weigh about 12 tons each. As this diameter is too great to permit that they should be carried horizontally, it was, therefore, necessary to load them upon the car in a vertical position. For this purpose a gondola car was especially prepared by cutting away a portion of the floor in the shape of two square holes of the suitable width and of a length a little less than the diameter of the paths. A heavy timber framework was then built up on the floor with a square opening through it to correspond with that in the floor. The different portions of this frame were fastened together by heavy bolts and tie rods. It was so arranged that each car would carry two paths for the carriage.

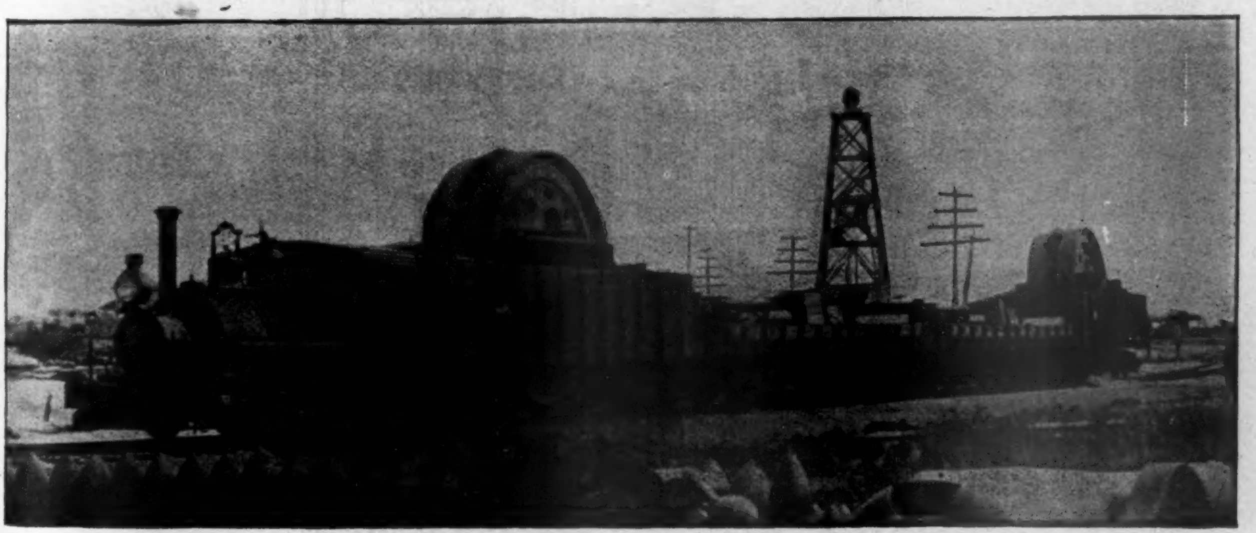
A part would be hoisted high enough to clear the car, which would then be run under it and the part lowered into position and then secured by wedges to the framework. The lowest point of the roller path is 7 in. above the top of the rail, and with the height thus created of 14 ft. 7 in. above the rail the

car can safely pass through any bridge or tunnel between New York and San Francisco.

The side frames and other parts of the carriage are loaded upon other cars. The two photographs illustrate both the single car with its load and the train consisting of four cars containing two carriages. Twelve cars with six carriages were shipped in September, and two in each one of the last three weeks in December.



GONDOLA CAR LOADED WITH MORTAR CARRIAGE PATHS.



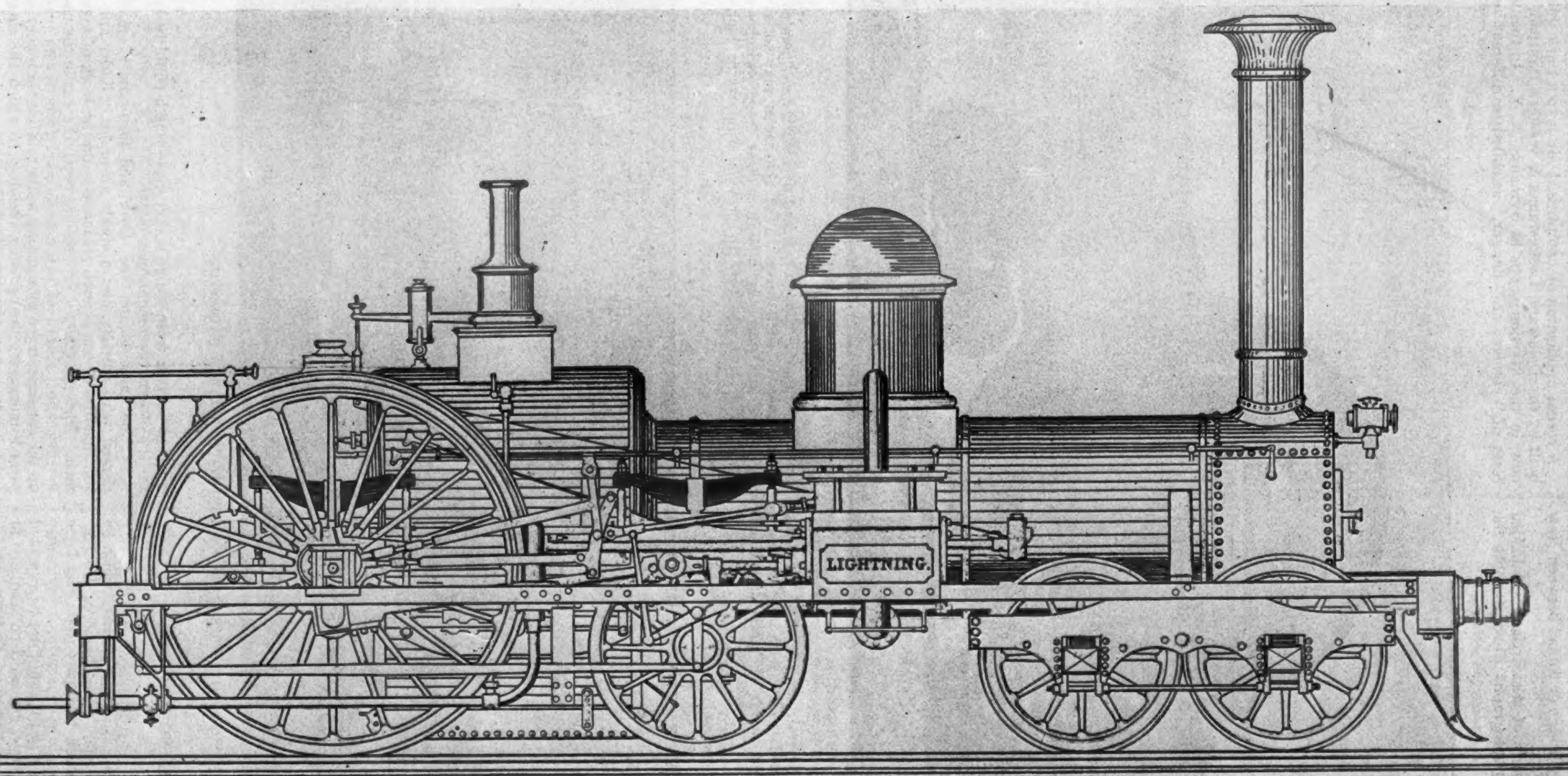
TRAIN OF FOUR CARS LOADED WITH MORTAR CARRIAGES.

## RAILROAD NOTES.

COMPRESSED air and its applications to railroad work received quite an exhaustive discussion at the hands of the Master Car-Builders' committee chosen to report upon that form of stored energy at the recent Saratoga convention. Evidently the committee did its work well; but it could not be expected that *every* application of compressed air could be tabulated in their report, or even recognized or discovered by them.

A recent application of compressed air is to a track gouger built by the Delaware, Lackawanna & Western Railroad, and now in the division shops at Syracuse, N. Y. In the usual form of "gouger" or "flanger," as called in different localities, the scraper or plough is raised by long levers operated by several men to each lever. That these men may act at the right time and raise the plough to clear frogs, switches and crossings, it was necessary to provide windows or look-out holes in the car, from which a very close watch could be kept for the obstructions mentioned above.

In the new flanger the lever and man-power are dispensed with entirely, and a single air-brake cylinder and 60 lbs. pressure of compressed air made to do the work of several men. The ploughs are hung underneath the car in the usual locality; but instead of being suspended from levers placed on the car floor, these ploughs are hung to a double rocker arm placed underneath the car floor framing, to which the air cylinder has its piston directly attached.




*Lightning*, 1849.

BUILT BY EDWARD S. NORRIS, AT THE NORRIS LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

The control of the compressed-air cylinder lies in a three-way cock, wherewith air is admitted to either end of the cylinder and exhausted therefrom at will of the operator, who sits upon a kind of deck or look-out house built on top of the car, much in the same manner that some freight cabooses are constructed. By means of compressed air and the three-way cock the entire control of the flanger is put within the limit of one man's capabilities. All the lever hands are dispensed with, and the flanger man sits up there in his little look-out house running the ploughs closer to, and putting them down again much quicker after passing an obstruction than was ever done by a hand-operated machine. Only a man or two need be sent out with the operator on a flanger, and they will be required only in case of accident.

Air is taken from the train pipe; but a special reservoir tank is provided between the train pipe and the flanger cylinder. The special tank takes air through a very small opening to the train pipe, so small, in fact, that the air pressure in train pipe is not diminished enough to set the brakes, even if the small opening mentioned be left open to the atmosphere. Train-pipe pressure is thus maintained in the special tank without affecting the air brakes.

The ploughs or scrapers (one for each rail) are hinged to the rocker arms and kept up to their work by chains extending forward and backward so as to form braces or ties to hold the scrapers in place. Thus the car can run either end forward and do the flanging equally well. In each chain a cast-iron link is placed. This link is shaped like the letter C, and, like it, has an opening in one side, so it can be hooked into the rest of the chain. The opening, or slot, is made diagonally instead of square across, so that the chain cannot unhook itself whenever it gets slack. The cast-iron links are cheap, and are easily replaced when broken. When the operator neglects to raise the ploughs during the passing of a switch or a crossing, the cast-iron links break before the chain can give way, thus preventing any danger of breaking anything else.

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SOME master mechanics have a better idea of or confidence in cast iron than is possessed by a majority of railroad engineers. Colonel Brown, Master Mechanic of the Delaware, Lackawanna & Western Railroad, at Scranton, Pa., evidently is one of the "cast-iron men," as he uses that material for guides on a number of the heaviest locomotives on his division. The cross-head is enlarged to take the big guide-bar made necessary by the use of cast iron. No broken guide-bars have been reported yet, and the cost of manufacturing is much less than the expense of forging and planing up steel or wrought-iron rods.

Spade handles are also forged differently in this shop than on most roads. Instead of being made solid with the rod and cut out on a slotter, the spade handles made in the Scranton shops are in two parts. Making the rod is about like finishing up a "stub end;" then the spade handle, formed in another piece, is bolted.

The different engineering treatment required to produce economy of the same machines is pretty well illustrated by a comparison of the culm-burning locomotives of the Delaware, Lackawanna & Western and the locomotives of the Manhattan Elevated Road, in New York; the former, especially in the mountain division, have to be fitted with enormous grate area, in order to do the work required of them. The latter, contrary to all precedent in railway locomotive practice, have very small grate area; and while the former grate areas have been increased to the limit allowed by the standard gauge of track, the grate area of the locomotives for the elevated railroad has been cut down to about 18 ft. with good results.

The difference between 18 sq. ft. and 80 sq. ft. for grate area is considerable, but it is fully met by the difference in conditions under which the locomotives are to be used, the constant stopping and short runs of the locomotives of the elevated road showing better economy with ample boiler room and heating surface and contracted grate area, while the long, hard pull of the big machines require the greatest amount of "lung power" (*i.e.*, grate area) that can be given them.

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THE municipal authority who orders engineers and firemen to be taken from their cabs under arrest for burning soft coal gives a fine exhibition of that human characteristic which is tolerated by society when the opposing armies of two generals commit wholesale murder. The cases are parallel, especially in the one exemplified by the arrest of engineers and firemen on the Long Island Railroad for violating the smoke ordinance. If one general should plan to kill his opponent, and thus end the struggle by the death of a single man, the successful plotter would be denounced as a murderer, as a man of anarchistic tendencies; but let his hirelings commit wholesale murder with those of the opposing commander, and it is only war.

In the case of the City *v.* The Long Island Railroad Company, had the authorities promptly arrested the directors of the company they would have been condemned as anarchists; but as they only imprison a few *servants* of the company, who are obeying orders in burning soft coal, then the dignity of the city is upheld, and the railroad continues to transgress.

I. F. H.

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## AN EARLY NORRIS EXPRESS LOCOMOTIVE.

THE engraving on the opposite page is from an old print of a locomotive built by Edward S. Norris, at the Norris Locomotive Works, when these were located at Schenectady, N. Y. The Norrises, who afterward moved their business of locomotive building to Philadelphia, began in Schenectady, and their old shop was the beginning of the present Schenectady Locomotive Works.

The *Lightning* had 7-ft. driving-wheels and 16 × 22 in. cylinders. The truck-wheels were 42 in., the trailing-wheels 48 in. and the boiler 42 in. diameter. The latter had 116 2-in. tubes, which were 10 ft. 3 in. long. The fire-box was 54 × 36 in. The weight of the engine was 20 gross tons. The engine was built and was used on the Utica & Schenectady Railroad.

Mr. William Buchanan, who remembers this engine very well, says that the boiler was too small to make steam, the cylinders were not large enough for the driving-wheels, and the wheels had not weight enough for adhesion, and that consequently the engine was not successful. It will readily be seen that without sufficient steam generating capacity, tractive force, or adhesion that a locomotive must be a very inefficient machine. It will be seen that even at this early date it had a stationary link-motion for its valve gear. A comparison with an illustration of one of Crampton's locomotives, published in *Clark's Railway Machinery*, will show that they closely resemble each other, and probably the Norris design was suggested by Crampton's engines. The system of locating the driving-axle behind the fire-box, with some minor novelties, formed the subject of a patent granted to Crampton in 1843. The first of his engines was built in 1846, and had six wheels. It was tested on the London & Northwestern Railway. Another, the *Liverpool*, with eight wheels, was built for that road in 1849. The side view of this engine, which is given in *Clark's Railway Machinery*, resembles very closely that of the *Lightning*. All the wheels of the *Liverpool* were attached to rigid frames, whereas it will be seen that the four front wheels of the Norris engine formed a truck or Anglice "bogie." The *Liverpool* had 8-ft. wheels and 18 × 24 in. cylinders, and weighed 35 tons, 12 of which were carried by the driving-wheels.

In commenting on this engine, Clark says: "The unsoundness of the policy of gettting up heavy engines, merely to show what can be done, is apparent. . . . This splendid monster worked the express train between London and Wolverton for some time, and on one occasion conveyed a train of 40 carriages within time—more than work for three ordinary engines; it was, however, laid aside on account of its excessive weight"—all of which sounds rather queerly in these days, when engines of more than double this weight are not uncommon.

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## BORK'S BRICK-LINED LOCOMOTIVE FIRE-BOX.

IN THE AMERICAN ENGINEER for September, 1893, there was published a translation of an article which appeared in *Glaser's Annalen für Gewerbe und Bauwesen*, describing a fire-box for locomotives designed by Mr. Bork, Locomotive Superintendent.

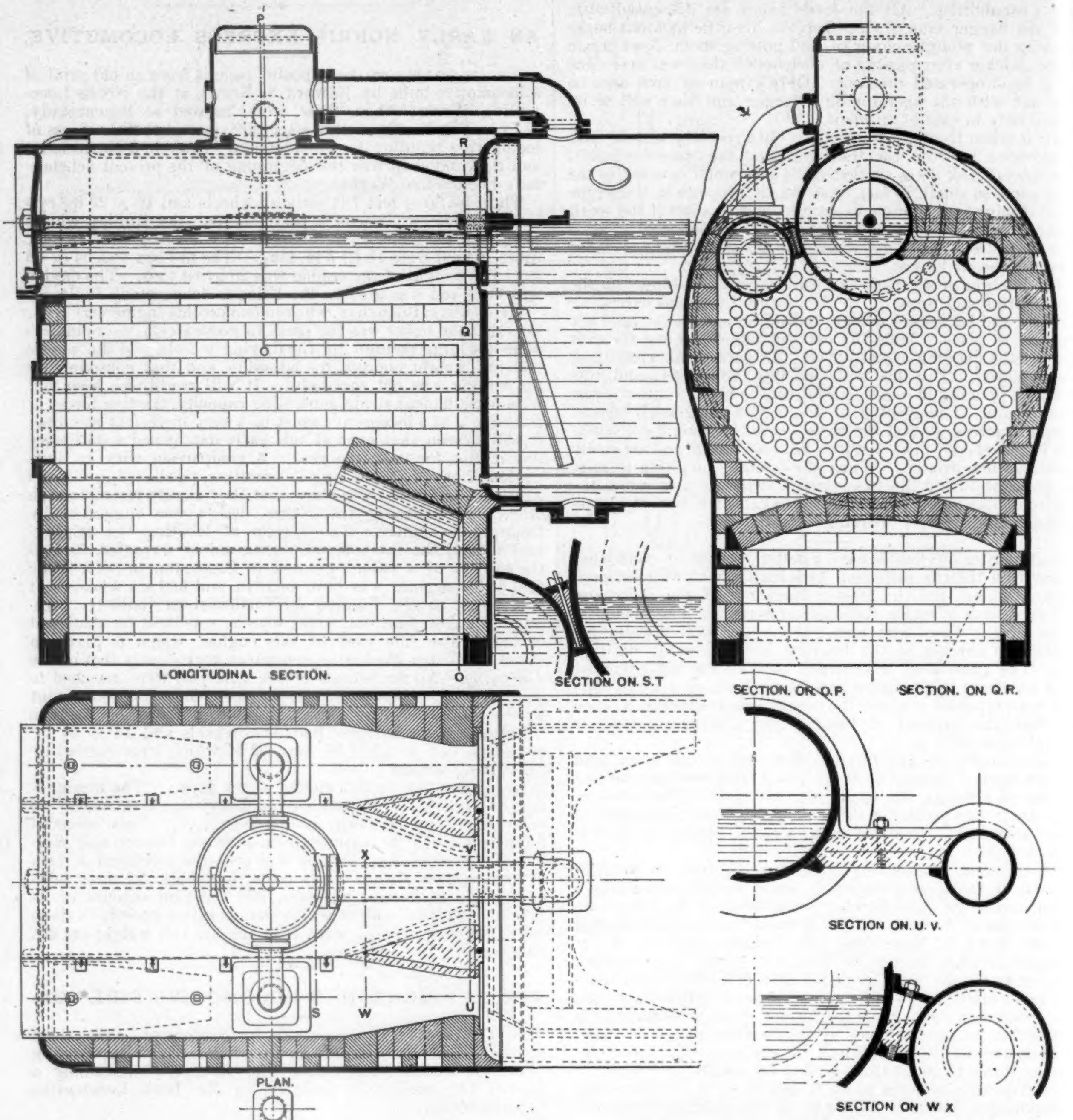
In that paper the author said:

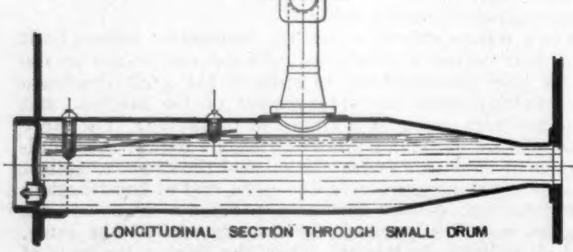
"It is a remarkable fact that the locomotive boilers built for the first railroads have been retained unchanged as the type for later constructions, in spite of the great disadvantages resulting from the arrangement of the fire-box, and which have been recognized from the beginning. The large number of stay-bolts and braces which are required, the universal use of flat surfaces for the sides of the fire-box, against which the steam pressure acts, the great cost of construction, its favorable arrangement for the deposition of scale, and the difficulties which it presents for the removal of the same, should all militate against it. Then the thicker the layer of scale that is formed, the greater is the loss of evaporative efficiency of the boiler. . . . .

"The renewal and maintenance of the fire-box, besides adding a very considerable amount to the repair account, also serve to keep the locomotive for a considerable length of time out of service. Besides this, even with the most scrupulous care, the fire-box must always be considered the most danger-

ous part of the locomotive, and it is well known that the great majority of locomotive boiler explosions take place either in the fire-box itself, or the outer shell of the same."

Besides being the most dangerous part of a locomotive, it may be added that the fire-box is the most expensive part in its first cost of construction, and also in its maintenance. It




BORK'S BRICK-LINED LOCOMOTIVE FIRE-BOX.

is a source of constant anxiety to those who run locomotives, and to those who have the responsibility of their care. This is due to the fact that the inside plates which are exposed to the fire, the stay-bolts and braces, and, in fact, the whole structure are subjected to great strains, which are very imperfectly understood, are exposed to constant deterioration, and are always liable to fail, and—as Mr. Bork has pointed out—more explosions occur in the fire-boxes than in any other part of locomotive boilers. If we could get rid of the plates exposed to the fire, to all stay-bolts, braces and crown-bars, and have no parts subjected to the excessive and uncertain strains which fire-boxes must resist, and if this could be done at a reduced first cost, less expense for repairs and maintenance, and no reduction, but rather an increase of efficiency, it must be admitted that it would be a very great advance.

Mr. Bork claimed in the paper from which we have quoted that he had achieved all these results. In that paper he said: "For building an entirely new boiler with the brick fire-box, having a capacity sufficient for the standard freight engine, the expense would be about 6,000 marks ($1,500), while the cost of a boiler of similar efficiency of ordinary construction (with copper fire-box) would be 11,000 marks ($2,750)." He said further: "The efficiency of the locomotive, after the new design of boiler was placed upon it, was at least equal to that which it had originally. . . . The coal consumption was generally 10 to 25 per cent. less, as shown by the premium awards." Continuing, he said: "Aside from the improved steaming qualities, whereby a lower consumption of coal pro-

duced the same efficiency, there are two facts which seem to particularly warrant the introduction of this new type of boiler, to wit:

"1. A very greatly reduced outlay in first cost, and

"2. Possibility of an important increase of steam pressure, and therefore an increase of efficiency, without a corresponding increase in the weight of the locomotive."

The author then went on to make a careful comparison between the expense of construction and maintenance of the copper fire-box and the brick-lined fire-box of his new construction. As copper fire-boxes are not used in America now, these figures do not show what the relative expense would be between the brick-lined box and the steel box used in this country; but his conclusions relative to the copper fire-box are that there is a saving of maintenance of about 29 per cent.

Notwithstanding these statements, which have not been refuted, and which there does not seem to be any good reason to doubt, the claims of Mr. Bork have been received with the greatest apathy and apparent scepticism by master mechanics and locomotive superintendents, both in this country and in Europe. There somehow seems to be an incapacity on their part to adjust their minds so as to be able to recognize the significance of what Mr. Bork and others have shown—viz., that the present costly and dangerous form of locomotive fire-box is not essential to its successful working, and probably is more expensive, less efficient, and not so economical as a fire-box may be if the water spaces around the fire are omitted, and a simple shell lined with fire-brick is substituted for what our colored brethren would call our old "misery."

In view of all these facts and hypotheses, we take pleasure in giving our readers engravings of the latest form of fire-box which Mr. Bork has designed. Naturally experience has suggested some improvements and changes. A comparison of the engravings given herewith and those published in our issue of September, 1893, will show that the chief change which Mr. Bork has made is in adding two additional crown cylinders over the furnace instead of having only one supplemented with a brick arch, as in his first design.

We are indebted to Mr. Charles Brown, of Basel, for the drawing, and also for some observations on Mr. Bork's fire-box and some extracts from a letter which he (Brown) has received from Mr. Bork. Mr. Brown says:

"Bork's memoir (published in The American Engineer, September, 1893) is very interesting, and is worth reading very attentively, for if what he says is true there is a future for this invention, notwithstanding that the routine people cry it down.

"The supporting cylinders employed by Bork for supporting the fire-box roof is, I think, an improvement, as it is here that these boxes first fail.

"Mr. Bork writes to me, as under, in reply to several questions I put concerning the durability, up-keep, etc., of his fire-boxes. These questions you will also find anticipated in his memoir:

"'We have now before us the experience of one and one-half years with the new locomotive boiler, and I can confidently assert that my expectations have been fulfilled; and although the heating surface is somewhat less than before the boiler was converted from a copper to a brick fire-box, that the engine performed its usual service with *less* fuel than with the copper box.

"'Leaky tubes have never been observed during the one and one-half years' service; repairs have consisted only in the renewal of the fire-bricks (six times) immediately above the fire. This work is done without having to go into the repairing shops; it takes about four hours, and is carried out in the engine house (Heitzhaus) during the regular wash-out stoppages.'"

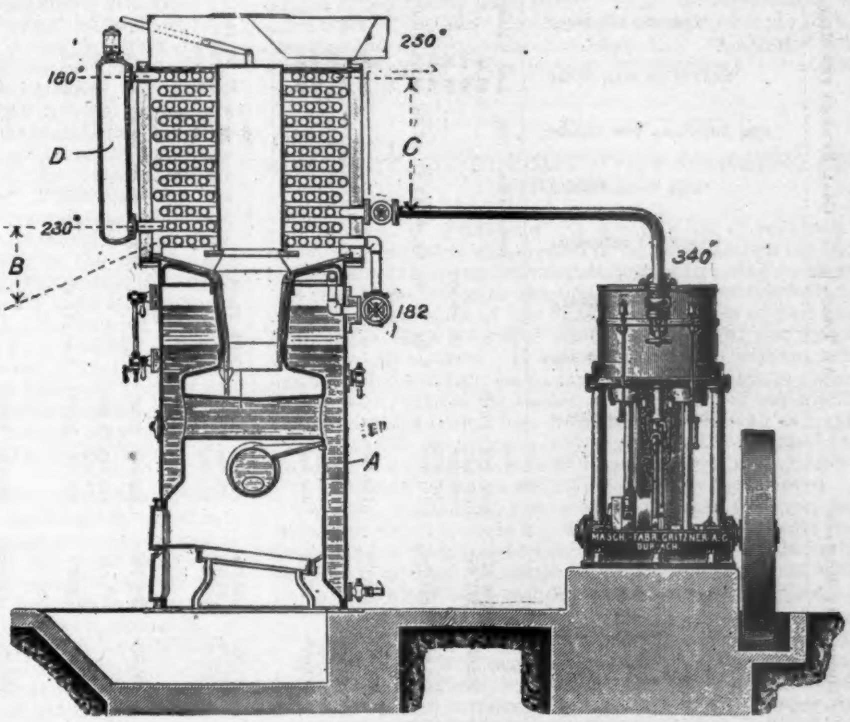
Mr. Brown adds: "One very important point has been brought to light by Bork's experiments: it is that the brick box requires less air for combustion than the water-space box! This has been proved by analysis of the products of combustion; the old fire-box requires per kilogram of combustible 26.6 kilograms of air, or together $26.6 + 1 = 27.6$ kilograms. The brick box requiring only 19.9 kilograms, or together $19.9 + 1 = 20.9$ kilograms. This being the case, the tubes have less work to do, the volume of gas being less, or, better said, a less surface suffices to extract the heat, the temperature being higher. This explains what was observed, that the temperature of the smoke-box was not higher than in the case of the water fire-box."

Whether the "routine" people will ultimately be able to grasp the significance of the facts which Mr. Bork has elucidated is still uncertain. Probably some mental trepanning will be required in order to give room for the idea in the minds of that class of persons who resist all innovations.

## SCHMIDT'S SUPERHEATED-STEAM BOILER AND ENGINE.

The engraving herewith represents a section of a boiler and a view of an engine which is the invention of Mr. William Schmidt. From a descriptive circular issued by the Gritzner Machine Works, at Durlach, Switzerland, we have made the following translation:

"Modern steam-engine practice has reached such a high degree of perfection at the present time, that it is difficult to conceive how any very great improvement can be made if we work along the beaten path. The great evil of the steam-




SCHMIDT'S SUPERHEATED-STEAM BOILER AND ENGINE.

engine of to-day consists in the fact that the slightest lowering of the temperature of the so-called saturated steam produces an immediate lowering of the pressure. Hence it happens that when fresh steam is admitted from the boiler into the engine some of it is condensed by the lower temperature of the cylinder walls, and it is therefore lost as far as the performance of effective work is concerned. The loss resulting from this is the greatest in the common condensing engine, and may amount to as much as 60 per cent. of the steam used. This loss can be diminished by the use of the steam jacket or by expanding through several cylinders, although this will be very far from doing away with it altogether. It has been known for a long time that superheated steam does not share in this disadvantage, in so far as the superheating reaches a definite point. Hence, several types of apparatus designed to accomplish these results have been designed. The reason why success has not attended these efforts lies in the fact that either the apparatus was not properly built, or that the superheating was not carried sufficiently far.

"The invention of Schmidt's superheating boiler therefore marks an interesting departure, and gives the power to obtain

## LOCOMOTIVE RETURNS FOR THE MONTH OF OCTOBER, 1894.

| Name of Road. | Number of Serviceable Locomotives on Road. | Number of Locomotives Actually in Service. | Locomotive Mileage. | | | | | Av. Train. | | Coal Burned per Mile. | | | | | | Cost per Locomotive Mile. | | | | | | | Cost per Car Mile. | | Cost of Coal per Ton. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Passenger Trains. | Freight Trains. | Service and Switching. | Total | Average per Engine. | Passenger Cars. | Freight Cars. | Passenger Train Mile. | Freight Train Mile. | Service and Switching Mile. | Train Mile, all Service. | Passenger Car Mile. | Freight Car Mile. | Repairs. | Fuel. | Oil, Tallow and Waste. | Other Accounts. | Engineers and Firemen. | Wiping, etc. | Total. | Passenger. | Freight. | |
| | | | | | | | | | | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Lbs. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | $ |
| Atchison, Topeka & Santa Fé | 864 | 787 | .... | .... | 306,870 | 2,058,213 | 2,615 | .... | .... | .... | .... | .... | 82.95 | .... | .. | 3.59 | 7.25 | 0.24 | 0 16 | 6.69 | 1.32 | 19.25 | .... | ... | 1.68 |
| Canadian Pacific | 610 | .... | 490,142 | 962,656 | 311,255 | 1,764,053 | .... | .... | .... | .... | .... | ... | 69.00 | .... | .... | 3.52 | 10.18 | 0.22 | .... | 5.76 | 1.12 | 20.80 | .... | 1.64 | 2.96 |
| Chic., Burlington & Quincy | 541 | .... | .... | .... | .... | 1,469.318 | ... | 5.15 | 19.86 | ... | .... | .... | 84.56 | .... | .... | 3.34 | 5.21 | 0.18 | 0.19 | 6.76 | .... | 15.68 | .... | .... | 1.26 |
| Chic., Milwaukee & St. Paul | 852 | .... | .... | .... | .... | 2,408,853 | .... | .... | .... | .... | .... | .... | 74.47 | .... | .... | 3.59 | 7.15 | 0.25 | ... | 6.84 | .. | 17.83 | .... | .... | 2.10 |
| Chic., Rock Island & Pacific | 564 | .... | 484,509 | 942,678 | 287,723 | 1,714,910 | .... | 5.50 | 18.10 | 54.86 | 75.87 | 42.28 | 64.74 | 10.02 | 4.58 | 3.87 | 6.33 | 0.21 | 1.57 | 6.09 | 0.44 | 18.51 | .... | .... | 2.04 |
| Chicago & Northwestern | 1010 | .... | 811,307 | 1,592,644 | 720,494 | 3,124,445 | .... | .... | .... | .... | .... | .... | 86.39 | .... | .... | 3.16 | 7.73 | 0.27 | .... | 6.27 | 0.76 | 18.19 | .... | .... | 1.77 |
| Cincinnati Southern | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Cumberland & Penn.* | ... | 23 | 5,385 | 39,595 | .... | 44,980 | .... | .... | .... | .... | .... | .... | 84.03 | .... | .... | 5.62 | 4.55 | 0.34 | .... | .... | 1.58 | 12.09 | .... | .... | |
| Delaware, Lackawanna & W. Main L | 213 | 195 | 73,310 | 605,937 | .... | 679,247 | 3,483 | .... | .... | .... | .... | .... | 78 93 | .... | .... | 3.13 | 5.80 | 0.40 | .... | 5.67 | .... | 15.00 | .... | .... | 1.47 |
| Morris & Essex Division | ... | 164 | 185,077 | 229,043 | 16.236 | 430,346 | 2,656 | .... | .... | .... | .... | .... | 65.61 | .... | .... | 3.56 | 10.25 | 0.32 | ... | 6.94 | .... | 21.07 | .... | .... | 3.10 |
| Flint & Père Marquette | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Hannibal & St. Joseph | ... | 69 | 66,048 | 137,809 | 38,966 | 242,821 | 3,624 | 5.04 | 17.04 | .... | .... | .... | 81.66 | 14.57 | 6.16 | 3.12 | 5.16 | 0.11 | 0.30 | 6.63 | .... | 15.32 | .... | .... | 1.33 |
| Kansas City, Ft. S. & Memphis | 138 | .... | 96,571 | 181,636 | 92,001 | 370,208 | 3,010 | .... | .... | .... | .... | .... | 64 22 | .... | .... | 3.29 | 4.71 | 0.30 | 0.38 | 7.34 | .... | 16.02 | .... | .... | 1.42 |
| Kan. City, Mem. & Birm | 42 | 36 | 35,211 | 53,775 | 12,636 | 101,622 | 2,823 | .... | .... | .... | .... | ... | 59.48 | .... | .... | 4.04 | 2.85 | 0.32 | 0.26 | 6.66 | .... | 14.13 | .... | ... | 0.96 |
| Kan. City, St. Jo. & Council Bluffs | .... | .... | .... | .... | .... | .... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | ... | .... |
| Lake Shore & Mich. Southern | 591 | .... | 374,540 | 800,795 | 458,168 | 1,633,503 | 3,047 | .... | .... | 62.09 | 89.36 | 47.65 | 69.30 | .... | .... | 2.85 | 5.19 | 0.10 | 0.05 | 6.97 | 0.12 | 15.28 | .... | .... | 1.49 |
| Louisville & Nashville | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .. | .... | .... | .... | .... | .. | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Manhattan Elevated | .... | 286 | 751,834 | .... | 67,811 | 819,645 | 2,865 | .... | .... | .... | .... | ... | 38.20 | .... | .... | 2.40 | 7.70 | 0.20 | 0.50 | 9.30 | .... | 20.10 | .... | .... | 4.00 |
| Mexican Central | 148 | 133 | .... | .... | .... | 451,556 | .... | .... | .... | .... | .... | .... | 61.89 | .... | .... | 4.00 | 11.39 | 0.40 | 0.12 | 4.93 | .... | 20.84 | ... | .... | 3.64 |
| Minn., St. Paul & Sault Ste. Marie | 104 | 82 | 89,707 | 137,420 | 29,608 | 256,435 | 3,127 | 4.64 | 21.48 | .... | .... | .... | 69.15 | .... | 4.59 | 3.77 | 8.40 | 0.25 | .... | 6.45 | .... | 18.87 | 3.61 | 1.04 | 2.39 |
| Missouri Pacific | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| Mobile & Ohio | 105 | 84 | 76,933 | 150,334 | 55,932 | 283,249 | 3,372 | .... | 23.50 | .... | .... | .... | 65.01 | ... | .... | 2.75 | 4.16 | 0.20 | 0.58 | 5.78 | 0.95 | 14.42 | .... | .... | 1.28 |
| N. O. and Northeastern | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .. | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| N. Y., Lake Erie & Western | .... | 265 | 442,511 | 795,032 | 251,406 | 1,488,949 | 3,000 | 4.50 | 24.80 | 84.50 | 135.10 | 87.05 | ... | 18.96 | 5.50 | 4.32 | 7.36 | 0.33 | 1.78 | 7.39 | 1.23 | 22.41 | .... | 1.54 | 1.34 |
| N. Y., N. H. & H., Old Colony Div | .... | .... | .... | .... | .... | .... | ... | .... | .... | ... | .... | .... | ... | .... | .... | .... | ... | .... | .... | .... | .... | ... | .... | .... | ... |
| N. Y., Pennsylvania & Ohio | ... | 287 | 129,494 | 408,844 | 157,351 | 695,689 | 3,379 | 5.40 | 19.60 | 69.10 | 124.10 | 84.60 | .... | 12.70 | 6.30 | 3.35 | 5.58 | 0.29 | 1.81 | 7.09 | 1.01 | 19.13 | .... | 1.53 | 1.07 |
| Norfolk & Western, Gen. East. Div.† | .... | ... | 99,389 | 322,137 | 57,853 | 479,379 | 2,771 | 5.40 | 21.00 | 47.42 | 111.61 | .... | .... | 8.86 | 6.41 | 6 04 | 3.60 | 0.27 | .... | .... | .... | 9 91 | .... | .... | ... |
| General Western Division† | .... | .... | 106,891 | 371,559 | 64,724 | 543,174 | 2,760 | 5.29 | 17.11 | 74.00 | 135.00 | 103.00 | 118.00 | 13.99 | 7.90 | 6.74 | 4.09 | 0.24 | .... | .... | .... | 11.07 | .... | .... | .... |
| Ohio and Mississippi | .... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | ... | .... | .... | .... | .... | ... | .... | .... | .... | .... | .... |
| Philadelphia & Reading | .... | .. | 454,180 | 828,114 | 491,033 | 1,773,327 | .... | .... | .... | .... | .... | ... | 79.30 | .. | .... | 4.95 | 4.46 | 0.37 | .... | 5.83 | 0.40 | 16.01 | .... | ... | .... |
| Southern Pacific, Pacific System | 721 | 652 | 625,498 | 1,149,844 | 245,732 | 2,021,074 | 3,100 | 5.33 | 14.77 | .... | .... | .... | 70.82 | .... | ... | 5.28 | 17.18 | 0.18 | 2.06 | 7.40 | 1.04 | 33.14 | .... | ... | 4.86 |
| Union Pacific | 739 | 427 | 427,714 | 991,269 | 397,924 | 1,816,907 | 2,830 | 6.47 | 20.43 | .... | .... | .... | 109.30 | 14.92 | 6.92 | 5.86 | 9.52 | 0.40 | .... | 7.68 | 0.93 | 24.39 | 1.46 | 3.83 | 1.73 |
| Wabash | 416 | 338 | 431,266 | 636,023 | 225,458 | 1,292,747 | 3,824 | 4.76 | 16.89 | .... | .... | .... | 88.85 | 15.05 | 6.54 | 3.61 | 5.28 | 0.28 | .... | 5.63 | 0.82 | 15.62 | 3.07 | 1.02 | 1.19 |
| Wisconsin Central | 149 | 116 | 142,003 | 216,646 | 81,765 | 440,414 | .... | ... | .... | .... | .... | .... | 82.27 | .... | .... | 2.64 | 6.76 | 0.15 | .... | 6.67 | 0.75 | 16.97 | .... | .... | 1.64 |

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and Southern Pacific, and New York, New Haven & Hartford rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs, and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

results that have heretofore been unknown in practical experience. As an example thereof we give a few figures which have been obtained in tests of Schmidt's apparatus :

| The Tests were Made by | Type of Engine. | Brake H.P. | Duration of Test. | Steam Consumption. Per Brake H.P. per Hour. | Coal Consumption. Per Brake H.P. per Hour. |
|---|---|---|---|---|---|
| Berlin Steam Boiler Inspection Company...... .... | Non-condensing single cylinder compound | 3.5 | 8 hours. | 11.7 Kg. | 1 90 Kg. |
| C. Schneider, Chief Engineer........,........ .... | | 39.0 | 8 " | 7.7 " | 0 90 " |
| G. de Grahl, Engineer.... . | | 20.0 | 8 " | 8.8 " | 1.20 " |
| Professor R. Schöttler, Brunswick, Geh. Rath. Prof. Lewicki, Dresden.. | | 69.0 | 8 ' | 7 9 " | 1.10 " |
| Professor M. Schroter, Munich.... ........... ........ | Condensing engine. | 62.0 | 8 " | 5.5 " | 0.69 " |

"The principal feature of the Schmidt invention lies in the simple arrangement of the superheaters. As shown in the figure, it consists of a steam generator formed of an ordinary upright boiler *A*, upon which a superheater consisting of spiral wrought-iron tubes is placed. The liberated steam enters the lowest coil in a damp condition, and is here dried by the hot gases. From the next to the lowest coil it passes into an upright chamber, *D*, in which it is comparatively quiet, and where an opportunity is given for the conversion of any particles of water that may have been entrained into steam. From here the steam goes into the upper coil and then passes downward through the principal superheater, from the top to the bottom, while the hot gases move in the opposite direction. From the lowest point of the superheater the steam flows out and into the engine. These then are the principal arrangements of Schmidt's superheating boilers, from which such fine results have been obtained. The prominent feature of the construction consists in the fact that the temperature of the walls of the tubes composing the superheater at no time reaches such a point that there is any danger of burning the metal. Therefore the durability of this important adjunct of the apparatus is well insured. Another advantage of Schmidt's boiler is found in that, while the ordinary production of steam from a boiler of such a size would be small, it is so increased in volume by the action of the superheater, that at 350° C. this increase may amount to as much as 35 per cent. above saturated steam of the same weight.

"The steam-engine differs very slightly from those heretofore in use ; it is exceedingly easy to manufacture, and this is especially so in that the cylinder has no stuffing-box and is open upon one end, so that the steam acts upon the pistons alternately. In other respects this steam-engine is built upon the lines of the modern engine, and has, above all, a very sensitive independent governor. In small engines up to 20 H.P. there is a hollow cross-head guide that is really superfluous, and the piston-rods are fastened directly to the inner half of the pistons ; on the larger engines the hollow guide is still retained, but it may be either bored out or flat.

"The lubrication of the cylinder is accomplished by means of a mechanical lubricator in which only valvoline oil should be used, such as is made by Breymann & Hubener, in Hamburg. The other parts are lubricated by the fixed drip oilers, in which any good oil may be used.

"The fly-wheel is of the regulation type and serves to keep the engine steady, and it can also be used as a belt-pulley.

"A feed-pump is attached to the machine, which furnishes the boiler with the water that may be required, passing it through a heater before it enters the boiler, wherein it is heated by the exhaust from the engine. It enters the boiler at a temperature of about 90° C."

A correspondent in whose mechanical judgment we have great confidence, and to whom we are indebted for the circular referred to, writes us :

"The inclosed circular of Gritzner & Co. will give you a general idea of the lines Schmidt is working on. He divides his generator into three zones : 1st, Zone A, boiler proper, has very little heating surface, about 1 sq. ft. per H.P. generates wet steam. This goes into the lower pipes, which form the 2d Zone B, where the steam is dried ; it then passes into a vessel, *D*, and from *D* to the upper pipes which form Zone 3, and are marked *C*, to the engine. The wet steam at 9 atmospheres leaves the boiler at a temperature of 182° C., passes through the pipes *B*, at 230° in the vessel *D*, the water carried over by the steam flashes into steam and leaves *D*, to enter the superheater proper, *C*, at a temperature of 180° or some 50° less than when it entered *D*. After passing *C*, it enters steam-chest of the engine at a temperature of 340°. It is to be observed that the steam enters the superheater at the highest point where the temperature of the waste gases is lowest (250°), and leaves the superheater where their temperature is highest. This point is very important, as it extracts the heat very effectually from the waste gases as they enter the chimney at the low temperature of 250°.

"The engines are single-acting, fitted with long pistons after the fashion of the gas-engine piston. This is necessary in consequence of the great heat of the steam ; with this precaution no difficulty is experienced with pistons or cylinders. The heating surface of the superheater and steam drier is four times as large as the wetted surface of the boiler. The 150 H.P. engine is fitted with double heat valves of the Sulzer type. You will agree with me that the Schmidt motor is a very original scheme.

"This subject is being steadily investigated over here. I was present at the trials of one of these engines, made by my friends, Messrs. Gritzner & Co. The engine is of 150 H.P., and runs at 150 revolutions per minute. The trials lasted three days, and were superintended by Professor M. Schröter, of Munich. A consumption of feed-water of 4.6 kilograms (10.3 lbs.) per indicated H.P. was found. This beats the best records obtained by Sulzer's or the Allis Company with triple-expansion engines. The engine is a compound condensing, not particularly well built either. Small non-condensing engines built by the same firm on the Schmidt principle show a consumption of feed-water per *brake* H.P. of about 8 kilograms (17.8 lbs.). This is most extraordinary for engines under 20 H.P."

## ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

The object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publications will in time indicate some of the causes of accidents of this kind, and to help lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with the information which will help make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a great favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in December, has been compiled. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

### ACCIDENTS IN DECEMBER.

Rochester, N. Y., December 1.—Robert Watt, fireman, and John Evans, engineer, were badly scalded by the collapsing of a tube on their locomotive while hauling a passenger train on the New York Central & Hudson River Railroad, near Grimesville this morning.

Lockport, Pa., December 2.—A collision occurred near here on the Central Railroad of New Jersey this morning between a coal and a freight train. The engine of the coal train was ditched, and the engineer, George W. Hull, was pinned beneath it and instantly killed. Lewis Gordon, the fireman, had both legs broken, and will probably die.

Alexandria, Va., December 3.—An engine hauling a local train on the Pennsylvania Railroad from this city to Washington jumped the track on the Long Bridge this morning. It plunged down a slight embankment and pinned Fireman W. T. Walker beneath it, killing him instantly. The engineer went down with the engine, but escaped with a slightly cut head.

Wilmington, S. C., December 6.—A collision on the Carolina Central Railroad occurred near Rockingham this morning between a freight train and a mixed passenger and freight train. Ellis Wells, engineer of one of the trains, was scalded to death, and the engineer of the other train was fatally injured.

Hartford, Conn., December 6.—A collision occurred on the New York & New England Railroad at this point this morning between a passenger train and a switching engine, in which Engineer Lewis of the switching engine was crushed to death.

† Wages of engineers and firemen not included in cost.

Chicago, Ill., December 6.—There was a collision between a freight train on the Chicago & Erie Railroad and a Belt Line freight at Seventy-ninth Street this morning. Engineer Williams, of the Erie, was seriously hurt about the spine.

Lafayette, La., December 8.—There was a collision between two trains on the Southern Pacific Railroad at Duson Station this morning. Engineer Daniels was slightly hurt about the face.

Oil City, Pa., December 10.—A freight train on the Western New York & Pennsylvania Railroad ran into a landslide near here this morning. Engineer Kirkman and his fireman were buried in the *débris*, but escaped with their lives.

Atlanta, Ga., December 9.—There was a collision this evening between a passenger train and a freight on the Southern Railroad near Bellwood Avenue. The fireman, Robert Pitman, was badly injured in the side and head, and John Dorman, the engineer, was hurt about the head and arms.

Seattle, Wash., December 11.—An express train on the Great Northern Railroad ran into a landslide to-night near Everett. Fireman Delis was fatally injured by the hot water and steam.

Massillon, O., December 10.—A. R. Johnson, an engineer on the Wheeling & Lake Erie Railroad, was instantly killed at Warrington to-day. He was leaning from the gangway of his engine looking at the tender trucks when his head was struck by a bridge, and he was thrown into the creek below.

Holland, Tex., December 12.—Engineer Young, on the Missouri, Kansas & Texas Railroad, was mysteriously injured to-day by being struck with a stone or piece of iron. Four negro tramps, who were stealing a ride at the time, were arrested on suspicion of having been the cause.

Bristol, Tenn., December 11.—A fireman on the Norfolk & Western Railroad was killed near Egleston, Va., to-day by being struck by the projections of the tunnel near that point. He was leaning out of the cab window at the time.

Milledgeville, Ga., December 12.—A train on the Central Railroad of Georgia went through a trestle near here this morning. The fireman was scalded to death, and the engineer was so severely scalded that he died of his injuries. The accident was caused by the washing out of the foundations by high water.

Pittsburg, Pa., December 13.—F. B. Fogle, a fireman on the Pennsylvania Railroad, was blown from his engine by a high wind at New Florence to-day. He was killed by the fall.

East Somerville, Mass., December 15.—Charles Waterman, an engineer on the Boston & Maine Railroad, was struck by a passing train at this place to-day and very seriously injured.

Bridgeport, Conn., December 16.—In attempting to avoid a collision, John Gates, an engineer on the New York, New Haven & Hartford Railroad, had an arm broken and received several severe cuts on the head. His injuries were caused by jumping from the engine before it had stopped.

Houston, Tex., December 16.—Two freight trains on the Southern Pacific Railroad collided in heavy fog this morning. Fireman Clements was fatally hurt.

Indianapolis, Ind., December 17.—William Armer was severely injured by being struck by some obstruction as he was leaning out of the window of the cab. The accident occurred on the Big Four Railroad, and the obstruction is supposed to have been a semaphore signal post.

Wilkesbarre, Pa, December 18.—A misplaced switch on the Lehigh Valley Railroad sent a passenger train into a lot of coal jimmies on a siding. Fireman Harry Stevens was badly squeezed about the hips. Engineer Harry Warren escaped with a cut on his face.

Port Jervis, N. Y., December 21.—Michael Kelly, an engineer on the New York, Lake Erie & Western Railroad, was badly scalded about the face and neck by the bursting of a gauge glass this morning.

Little Rock, Ia., December 21.—An express train on the Iron Mountain Railroad was wrecked here to-day by running into a cow. Engineer Stansbury and Fireman Trendley were caught in the wreck and severely though not fatally injured.

Spokane, Wash., December 22.—A passenger train on the Oregon Railway & Navigation Line struck a soft place in the track to day, causing the rails to spread. The train was a double header, and both engines were ditched. Engineer Walker was pinned beneath the wreck, and so badly scalded that he died soon afterward. The other engineer and one fireman had each one leg broken and received internal injuries.

New Orleans, La., December 23.—At midnight to-night there was a rear-end collision at Viot, on the Southern Pacific Railroad, when a freight train ran into a passenger train. Fireman C. Russell, of the freight, jumped and was killed.

Lafayette, Ind., December 24.—Two freight trains on the Big Four Railroad collided about three miles from here this morning. Engineer Elijah Campbell was buried under the wreck of his engine and killed.

Prescott, Ariz., December 24.—A broken rail on the Atlantic & Pacific Railroad caused the wrecking of a passenger train near here to-day. The engineer was slightly injured.

Waxahachie, Tex., December 25.—There was a collision on the Dallas & Texas Central Railroad at this point to-night. Engineer Bob Mays had both legs hurt.

Nashville, Tenn., December 25.—A bad wreck was caused on the Louisville & Nashville Railroad south of here to-night by some cars that had run out from the siding to the main line. Engineer Daniel Shugart and Fireman Steve Pettit are seriously scalded. It is supposed that the cars were run out by some train wrecker.

Chicago, Ill., December 29.—In a rear-end collision on the Chicago, Burlington & Quincy tracks to-night, Richard Walsh, a fireman, was badly scalded and had both legs crushed.

Tacoma, Wash., December 30.—In a collision between a gravel train and a hand-car near Olequa to-day, on the Northern Pacific Railroad, Fireman D. A. Ames was killed.

Topeka, Kan., December 29.—The side rod of an engine on the Atchison, Topeka & Santa Fé Railroad broke near Peabody this evening. It tore away one side of the cab and hurled the engineer to the ground. He received five or six scalp wounds on the side and back of the head, and was bruised about the head, body and legs.

Knoxville, Tenn., December 30.—An arch pipe on an engine on the Southern Railway exploded near Sweetwater to-night and scalded the engineer, John W. Ramsey, so badly that he died from the effects.

Our report for December, it will be seen, includes 32 accidents, in which 11 engineers and 9 firemen were killed, and 17 engineers and 9 firemen were injured. The causes of the accidents may be classified as follows:

| | |
|---|---|
| Blown from engine | 1 |
| Broken rail | 1 |
| " side-rod | 1 |
| Bursting arch-pipe | 1 |
| " gauge-glass | 1 |
| Cattle on track | 1 |
| Collapsed tube | 1 |
| Collisions | 11 |
| Derailments | 1 |
| Jumping from engine | 1 |
| Landslides | 2 |
| Misplaced switch | 1 |
| Running into hand-car | 1 |
| Run over | 1 |
| Spreading rails | 1 |
| Struck by missile | 1 |
| " " obstruction | 3 |
| Train wreckers | 1 |
| Trestle washed away | 1 |
| Total | 32 |

## PROCEEDINGS OF SOCIETIES.

**Central Railway Club.**—At the January meeting the Committee on Freight-car Doors and Hangers made a report, supplementing that presented at the December meeting.

**Engineers' Club of Philadelphia.**—At the December meeting Mr. John L. Gill, Jr., read a paper on boiler explosions, in which he exhibited and explained a table showing the energy stored in boilers of different types, dimensions and horse powers, and the height to which this energy could throw the boiler, with its weight of water, if allowed to act through an explosion.

**Engineers' Club of St. Louis.**—At the January meeting Colonel E. D. Meier read a paper on Chimneys and Chimney Drafts. The subject was considered with special reference to modern boiler practice and American coals. Computations usually made of stack capacity assumed the chimney gases to be of the same specific gravity as air. This is not true, as when combustion is complete the gases are really a mixture of carbonic acid gas, nitrogen, and steam; the proportions varying with different coals. As these require different amounts of air, the varying weights of the gases of combustion cause a difference in the draft power of the same chimney. It is rare that just the proper amount of air is admitted, and there is a loss when the amount is too little or too great. Very often there is a surplus, reaching sometimes as high as 100 per cent. Tables were presented showing these facts clearly for five well-known coals: Anthracite, New River, Youghiogheny,

Mount Olive, and Collinsville. Computations were made showing how the capacity of a chimney could be increased much beyond the normal by raising the temperature of the gases, the result always being accompanied by a corresponding loss in efficiency. It was shown that the same capacity could be obtained without loss of efficiency by increasing the height of the chimney. A table was given showing the changes in the capacity of a given chimney by varying the temperatures of the gases; also the change of height necessary while maintaining a constant temperature. Another table showed the effect of different coals on the velocity of the gases, and on the areas of chimneys, the velocity being kept constant. The chimney formulæ of Smith, Kent, and Gale, and the experiments of De Kinder, were discussed. A table was given showing appropriate heights and areas of chimneys for powers from 75 H.P. to 3,100 H.P., assuming 7 lbs. of water evaporation per pound of coal, and 5 lbs. of coal per H.P. per hour. The effect of long flues leading to chimneys was also discussed. It was shown that where a number of boilers were to be connected to the same stack, its dimensions could be reduced proportionately after the first few boilers, as they would never all be fired at the same time.

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**American Railway Master Mechanics' Association.**—The Secretary has sent out a number of circulars issued by the committees that have been appointed to report at the June convention. They are, in substance, as follows:

THE CAUSES OF BULGING OF FIRE-BOX SHEETS.

Is the difficulty caused—

1. By accumulation of mud or scale, preventing the sheet from receiving the necessary protection of the water?

2. Insufficient water space, preventing free circulation, and tending to drive water from sheet?

3. Bad water—that is, water containing such impurities and other hurtful substances, producing excessive foaming and tendency of water to leave the sheet?

4. Do you consider that the fact that the inside of the sheet is hotter than that next to the water has any influence on the bulging of sheets? If so, can you suggest a practical remedy?

5. Does the spacing of stay-bolts have anything to do with the bulging of sheets? Do you consider that closer spacing would provide a partial remedy?

6. Have you noticed that the use of oil in boilers to neutralize the evil effects of bad water has had a tendency to increase the bulging of sheets? In stationary boilers there has been an insoluble soap, formed by oil and water impurities, deposited on furnace sheets, which caused over-heating. Has anything of this character been noticeable by you in locomotive boilers?

7. Have you any reason to believe that the variation of temperature between the outside and inside of sheets has had anything to do with the breaking of stay-bolts?

In sections where bad water is prevalent, experience has led to a constant fight to keep boilers clean, and when very little neglect shows itself in the bulging of sheets and other serious results, it seems wise and helpful to get all the practical experience possible, with a view to broadening the scope of the committee's inquiry; and any information relative to the subject, or concerning (*a*) methods of preventing fire-box sheets from bulging, or (*b*) how to take care of boilers in bad-water districts, will be pertinent and very acceptable.

Answers to be sent to P. Leeds, Superintendent of Machinery, Louisville & Nashville Railroad, Louisville, Ky.

RIVETED JOINTS.

The committee especially request that the information furnished should apply only to the latest practice, and should not include data relative to old styles and types, unless such joints represent present practice. To facilitate the work of the committee, it is especially requested that all information called for in the first ten items on a drawing or tracing 8½ × 10½ in. in size, showing only one joint on each drawing or tracing; all joints used should be furnished and every drawing should be fully dimensioned. A sufficient amount of each joint should be shown to enable a calculation to be made of its efficiency, hence please show not less than three rivets of the row with greatest pitch. 1. Thickness of stock plates or sheets. 2. Thickness of inside butt or welt strips. 3. Width of inside butt or welt strips. 4. Thickness of outside butt or welt strips. 5. Width of outside butt or welt strips. 6. Diameter of rivet or rivets. 7. Diameter of rivet hole or holes. 8. Distance from edge of stock and welt sheets to centre of first row of rivets. 9. Distance between each row of rivets. 10. Distance (pitch) between each rivet on each row. 11. Are rivet-holes punched or drilled? 12. If sheet is punched or drilled, do you remove the burr from the edge of the hole before assembling the sheets? 13. Do you ream the rivet-holes after assembling the various sheets? 14. In punching your sheets, do you punch them so that the smaller diameter of the holes will be together when assembled, or *vice versa*? 15. Do you use iron or steel rivets? 16. Do you single or double-rivet the mud-ring? 17. Do you consider it advisable to double-rivet the circumferential seams of a locomotive boiler? If so, why? 18. Have you ever seen the joints in a fire-box double-riveted? 19. Have you ever made any physical tests of riveted joints? If so, please give us the results obtained, and how closely the results compared with the calculated strength.

The committee would also be pleased to receive information relative to your practice in riveting domes, mud-rings, boiler heads, fire-door and other sheets in a boiler, and your reasons for adopting such practice. In order that the committee may have ample time to compile and work up its report, kindly have all replies forwarded not later than February 15, to A. E. Mitchell, Superintendent of Motive Power of the New York, Lake Erie & Western Railroad, 21 Cortlandt Street, New York City.

BEST MATERIAL FOR BOILER TUBES.

The committee desires a full expression of opinion, and propounds the following questions:

1. What is the best material for locomotive tubes? 2. Please give your reasons for this preference. 3. In ordering tubes, do you furnish specifications? If so, please send a copy of same. 4. In your opinion, would a tube made of a *fair quality* of material, combined with a safe end made of a *good quality* of material, answer for all practical purposes? 5. What is the maximum length of locomotive tubes of different diameters? 6. What should be the thickness of metal for tubes of different diameters? 7. How often may tubes be pieced out with advantage and safety? 8. When and for what causes should tubes be condemned? 9. How do you test tubes and safe ends? 10. In making specifications for tubes, is the effect on them of the water used taken into consideration? 11. Describe your methods of fastening tubes at front and back end, say whether copper ferrules, and what kind of tools are used for caulking and turning over the ends of tubes.

Please answer these questions, and mail same to T. A. Lawes, Mechanical Engineer of the Chicago, Cleveland, Cincinnati & St. Louis Railway, Indianapolis, Ind.

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**Prizes for Railroad Inventions.**—The Verein of German Railroads has appropriated 30,000 marks ($7,500) to be distributed in prizes every four years for remarkable inventions and important improvements that are brought out in the domain of the railroad service. These prizes are to be divided as follows:

*A.* For inventions and improvements in the domain of construction and mechanical equipment of railways: A first prize of 7,500 marks; a second of 3,000 marks, and a third of 1,500 marks.

*B.* For inventions and improvements in the domain of the methods of operation, and that of the maintenance and development of the methods of operation. A first prize of 7,500 marks, a second of 3,000 marks, and a third of 1,500 marks.

*C.* For inventions and improvements in the domain of the administration and the operation of railroads, as well as that of railroad statistics, and for valuable literary work in the province of railroad work of all kinds. A first prize of 3,000 marks, and two second prizes of 1,500 marks each.

Without desiring to exclude from the competition other inventions and improvements appertaining to the railroad service, and without desiring to limit the commission in the examination of things that may have an influence on their decision, the following subjects have been selected as being especially worthy of consideration:

(*a*) Improvements relating to the construction of locomotive boilers, especially such as have for their object, without any great increase of the dead weight, a greater safety against the dangers of explosion, a better utilization of the fuel, lessening the amount of sparks that are thrown, and a saving in the expense of maintenance.

(*b*) Manufacture of strong and durable hose for conveying steam and compressed air for the rolling stock.

(*c*) An arrangement for permitting the trainmen to safely couple cars equipped with the American automatic coupler and the standard coupler of the Verein.

(*d*) Construction of a practical and cheap brake for freight cars.

(*e*) An automatic arrangement that will prevent the displacement of switch points during the passage of a train.

(*f*) An apparatus that is not complicated, for signalling when the entire train, including the very last car, has passed the switch points.

(*g*) A system of weighing that will permit of the weighing of cars in motion, whether detached or in a train.

(*h*) A proposition for the simplification of the accounts of the interchange of rolling stock.

If in any of the three groups the commission cannot decide on the allotment of the first or second prizes to any invention or improvement that has been presented for its consideration, the examining commission can divide the sum allowed for this first or second prize in the group in question, so as to grant several second or third prizes. Furthermore, the sum allotted to any one group may be divided among the others.

The conditions are as follows:

1. Only those inventions and improvements are admissible that have been brought out during the term specified below.

2. To be admitted to the competition, the invention or improvement must have been put into use before application upon one of the railroads forming a part of the Verein of German railways, and the request to enter the competition must be seconded by this railroad.

3. The project must be accompanied by a detailed description, together with drawings and models, etc., so as to convey to the judges a complete knowedge of the kind and nature of the device, the possibility of its operation, and the efficiency of the invention or improvement in question.

4. The obtaining of a prize shall not prevent the inventor from exploiting or soliciting a patent. Furthermore, each candidate for a prize for inventions or improvements must submit to the officers of the Verein a statement of the conditions upon which he will concede to it the right to use the invention or improvement.

5. The Verein has the right to publish the successful inventions.

6. All literary works submitted must be in triplicate. One of the copies will be placed in the library of the Verein, the other two will be returned to the candidate if he shall make a formal application for them.

7. The applications must contain the proof that the inventions and improvements have been brought out and the literary works published during the period named below. A commission composed of twelve members will be appointed by the Verein to examine into the projects that are presented, and decide whether the prizes are to be awarded and to whom. The first award will embrace all inventions and improvements that have been brought out between July 16, 1887, and July 15, 1895. Therefore all inventions and improvements that are to be presented to the commission must be executed before the date mentioned. The same statement also applies to all literary works. All applications should be sent, free of all charges, to *Kranoid*, in care of the Verein, at No. 3 Bahnhofstrasse, S. W. Berlin, Germany, between January 1 and July 15, 1895.

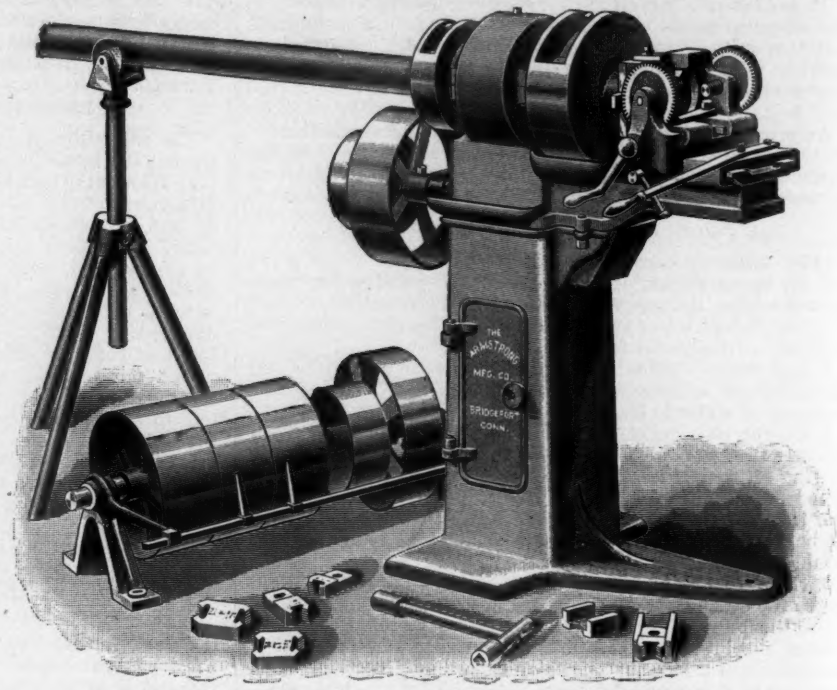
## ARMSTRONG PIPE-THREADING AND CUTTING-OFF MACHINE NO. 2½.

STEAM-FITTERS and others having to do with the cutting and threading of pipe will find in this machine a most convenient tool built for their especial line of work. It is an improved form of the No. 2 pipe-threading and cutting-off machine for hand or power, built by the Armstrong Manufacturing Company, Bridgeport, Conn., and retains the many attractive features of that machine in addition to others peculiarly its own. It is very compact, rigid and durable, and does not require the services of a skilled operator. All of the gears and working parts are enclosed in an oil-tight chamber, which insures their perfect lubrication, and effectually keeps out dust, dirt and chips which might otherwise get to them and thus interfere with the perfect working of the machine.

In one particular this machine differs essentially from all other pipe-cutting and threading machines of its class built by the Armstrong Company. In its operation the *pipe* revolves instead of the dies, being held securely by tight-gripping chucks.

For radiator steam coil works, etc., and other services where the greater number of pipes are of comparatively short lengths, this will be found a particularly desirable arrangement. The dies and cutting-off tool are held stationary, and are opened and closed by means of a double-geared crank-handle, as shown. Expanding dies are used in connection with a self-centring and powerful gripping chuck, insuring speed in cutting off and threading a pipe. They are furnished to thread from 1 in. to 4 in. inclusive.

Quick interchangeability of the various sizes of dies, coupled with a construction which permits of separate adjustment for three different sizes, enables the operator to thread pipe to suit all variations in ordinary fittings, and to open and close the dies any number of times without changing the adjustment. Again, either of the sizes may be used alternately without change of adjustment, or the dies may be quickly taken out to permit of the free passage of the pipe to be cut off, and the adjustment still remain unchanged. An objection frequently raised against machines using expanding dies is, "Our men are not skilful enough to use expanding dies without threading some of the pipe too large and some of it too small."



ARMSTRONG PIPE-THREADING AND CUTTING-OFF MACHINE.

This has been met and successfully overcome in the tool here shown. Though the dies are quickly opened after threading a piece of pipe, yet they may be as quickly closed together again without the least danger of variation, unless intentional.

The weight of this machine is about 700 lbs.; with counter-shaft, 850 lbs. Speed of counter-shaft should be about 225 revolutions a minute.

### Recent Patents.

FARNSWORTH'S GAS-COMPRESSING PUMP.

THE objects of this invention are to reduce the height of a vertical machine, to facilitate access to the parts and relieve the foundation of strains; to reduce to a minimum the angularity of the connecting-rod during the latter part of the stroke, and to improve various details of construction.

In the accompanying drawings, fig. 1 is a side elevation of a double cylinder compressor embodying my improvements, fig. 2 is a vertical section thereof, and fig. 3 is a cross-section on the axis of the rock shaft.

The cylinders $A$ $A$ (fig. 2) are open at each end, and are supported by flanges $a$ on a suitable base, $B$, consisting of preferably two parts united by a packed joint, $b$, on a horizontal plane. The upper portion of the base has two necks, $b'$, in which the cylinders are received, their lower ends depending into the base, as shown. The joint between the neck $b'$ and the flange $a$ is packed, so that the base forms a gas-tight chamber. A pipe, $B'$, provided with a suitable stop valve, con-

nects the base with the evaporating coils. The lower portion of the base is preferably in one piece, to form a reservoir for lubricating oil. At $B^2$ are covers to hand-holes for giving access to the bearings of the connecting-rods. In each cylinder, just below the flange *a*, are one or more ports, *a'*. The upper end of each cylinder is closed by a check-valve, *C*, which cuts off the cylinder from a chamber, *D*, from which proceeds a discharge pipe, *E*, having a stop-valve, *e*, and connecting with a common pipe, *E'*, running to the condenser.

In each cylinder is a piston, *F*, tubular in shape, and provided with a number of packing rings, *f*. The upper end of the piston forms a seat for an upwardly closing valve, *G*, which slides on vertical guides, *f'*, on the inside of the piston. A ring, $f^2$, screwed into the lower end of the piston limits the play of the valve. A socket is formed in the under side of the valve to receive the ball *h* on the upper end of the connecting-rod *H*, the ball being confined in the socket in any suitable manner, as by a gland, *g*. The lower end of the rod *H* is provided with brasses, *h'*, for connecting it with a wrist-pin, *i*, on a rocker, *I*. The brasses can be adjusted by a wedge, $h^2$, and screw, $h^3$.

The rocker *I* is keyed to a shaft, *K*, journalled in bearings $b^2$ integral with the lower portion of the base. The rocker has a working fit between the inner faces of these bearings, which are bored out cylindrically, and are lined with bushings, *L*, turned to an outside fit in the bearings and bored out to suit the long and preferably taper journals *k* on the shaft *K*. A gas-tight cover, $b^3$, incloses one end of the shaft. The other end passes through a stuffing-box, $B^3$, and is supported in an outboard pillow-block, *M*. The axis of the shaft lies preferably in the plane of the joint *b* between the upper and lower portions of the base. Fastened to the shaft outside the base is

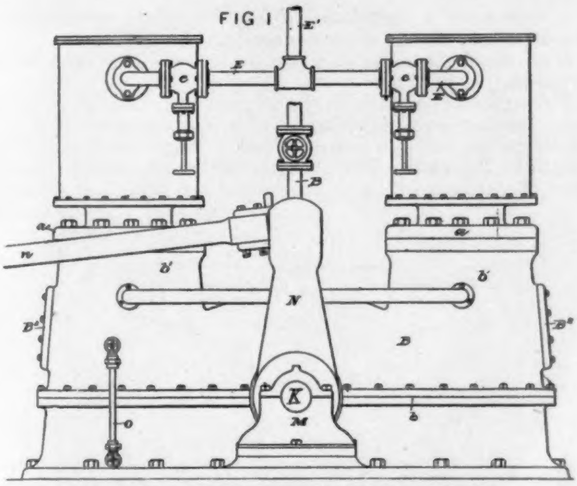


FIG I

FARNSWORTH'S GAS-COMPRESSING PUMP.

a rocker arm, *N*, to which may be attached a rod, *n*, for connecting it with an engine or other motor.

The wrist-pins *i* and shaft *K* are not in line with each other, but the shaft stands above the line joining the pins, so that each pin is distant from the shaft more than half the distance between the axes of the cylinders *A*. The proportions are such that when a piston is at the bottom of its cylinder, as at the right of fig. 2, the angularity of the rod is the greatest; but when the piston has made half its up-stroke, the pin *i* intersects the axis of the cylinder, and the rod coincides with said axis. The continued upward movement of the rocker arm swings the rod slightly outward for the next quarter of the stroke, but during the last quarter the rod again approaches a central position, which it reaches at the end of the stroke, as seen at the left of fig. 2. The dotted lines in this figure show the paths of the pins *i*. It thus appears that during the latter half of the stroke, when the resistance of the gas in the cylinder is greatest, the angularity of the rod is least, thus reducing to a minimum the wear and strain. It also appears that the line joining the centre of the wrist-pin and the axis of the shaft does not stand at right angles to the axis of the cylinder until three-quarters of the stroke has been made.

In operation, the downward movement of the rod *H* first draws down the valve *G* from its seat in the upper end of the piston. When the lower end of the valve strikes the ring $f^2$, the piston is carried downward, the gas in the base passing into the cylinder past the open valve *G*. On arriving at the bottom of its stroke the piston uncovers the ports *a'*, which permit the gas to enter the cylinder freely and insure a full charge at evaporating pressure. The upward movement of the rocker arm first closes the valve *G* and then carries up the piston, compressing the gas in the cylinder until it equals the pressure in the condenser, when the check-valve *C* opens, and the gas passes into the condenser, where it is liquefied. The construction of the piston is such that there is perfect freedom from restraint, avoiding unequal wear, and insuring prompt and correct action. The ball joints, guides in the pistons, pins and shaft bearings are all lubricated by the oil in the lower portion of the base, which is preferably carried at

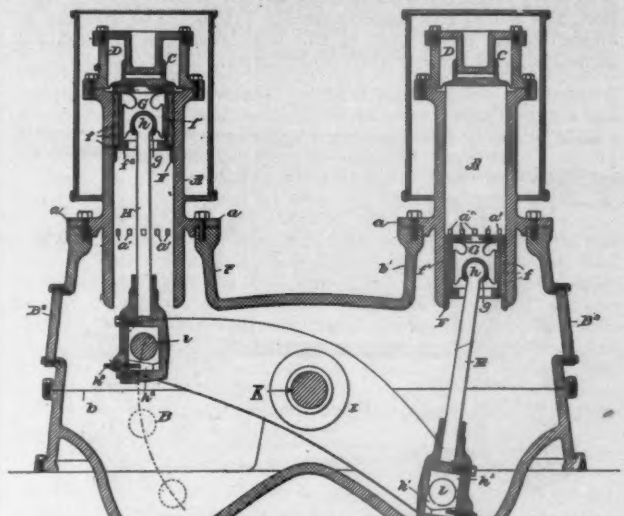


FIG. 2

FARNSWORTH'S GAS-COMPRESSING PUMP.

the height of the centre of the shaft *K*, but may be varied to suit. The level of the oil is shown by a gauge, *O*. At each stroke the descending rocker arm throws up a spray which amply lubricates the parts not immersed in the oil.

The inventor is Mr. Thomas Farnsworth, of San Antonio, Tex. His patent is numbered 530,097, and dated December 4, 1894.

## THE HINCKLEY SLACK ADJUSTER FOR RAILROAD CAR BRAKES.

There are principally two methods for automatically taking up or compensating for the wear and consequent slack due to

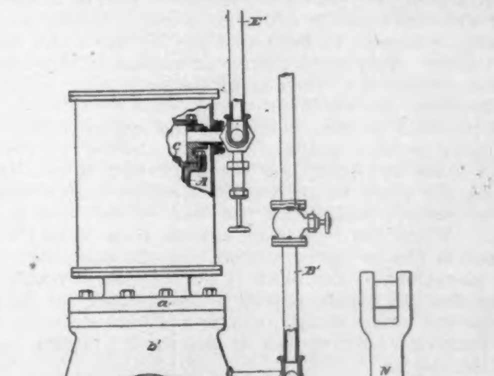


FIG. 3.

FARNSWORTH'S GAS-COMPRESSING PUMP.

the wearing away of brake-shoes. One is to shorten up some of the connecting-rods when the shoes have been worn; the other is to adjust the fulcrum or fulcra of one or more of the levers as the wear of the shoes increases.

The invention illustrated herewith has reference particularly to the latter method, and consists generically in interposing between two levers of the system a connection which, so long

as the throw or extent of movement of the levers is normal, will remain inactive, but which, when the movement of the levers, or either of them, increases by reason of slack in the rigging, operates to shift the fulcrum of the lever which has a stationary fulcrum.

Specifically the invention consists in connecting the live lever 2 and the dead lever 1 together by means of a rod, 5, having a connection with one of the levers which allows it to move independently of the lever in one direction, and causes it to carry the lever with it when moved in the opposite direction, and which rod is automatically extensible so that any increase in the movement of the live lever due to slack will cause the dead lever to shift its fulcrum.

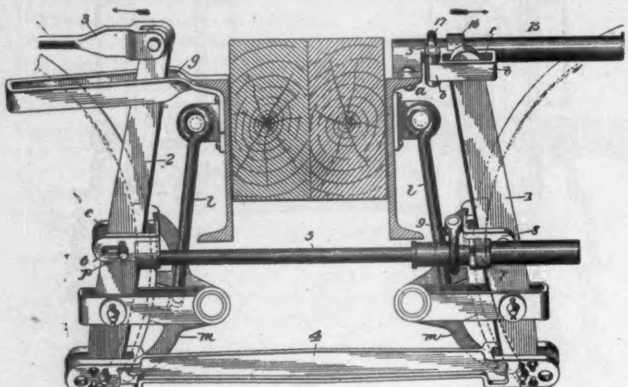


FIG 4

THE HINCKLEY BRAKE SLACK ADJUSTER.

Fig. 3 is a side view, in which 1 indicates what is commonly known as the dead lever; 2 the usual live lever; 3 a portion of the brake operating rod; 4 a connecting-rod securing the two levers together for operation in the ordinary manner.

15 denotes a guide-rod and support for the adjustable fulcrum of the dead lever 1. It is firmly bolted at its inner end to any convenient part of the truck or framing, as indicated in the drawings at *a*, and is preferably made hollow or tubular for lightness and strength. A sleeve, 16, encircles this guide-rod and slides freely to and fro thereon, and the outer end of the rod is preferably provided with a flange, *f*, to prevent the sleeve from going off the end of the rod. Cast or formed integrally with this sleeve is a fulcrum block, *b*, having a recess or opening, *r*, therein to form a keeper for the upper end of the dead lever. This block carries an automatic gripping device which permits it to move along the supporting rod freely in one direction, but which grips and binds the block to the rod and prevents it from moving in the opposite direction. The gripping device consists of a loop or shackle, 17, pivoted upon the block and encircling the guide-rod, stops *s* being formed on the block to prevent the shackles from swinging past a line perpendicular with the face of the block in one direction. When the loop rests against these stops the fulcrum block is free to move outwardly on the supporting rod, but any movement of the block in the opposite direction will cause the shackle, which, as will be understood, fits the surface of the rod rather snugly, to grip and bind upon the rod, thereby forming a positive lock or stop against reverse movement of the block.

5 indicates a connecting-rod between the live and dead levers, which, in connection with the said levers and the automatic gripping devices hereinafter described, constitutes the adjuster proper. This rod is pivotally connected to the live lever in any suitable manner so as to move longitudinally as the lever swings backward and forward. It is preferable to connect the lever with the rod, so that it (the lever) may have a certain movement independently of the rod, and this connection is shown in the drawings as formed by means of a pin, *p*, in the lever which passes through a slot, 6, in the clip or stirrup *c* secured to the end of the rod and forming the immediate connection between it and the lever.

Pivoted to the dead lever is a stirrup or clip, 8, preferably similar in general structure to the clip *c* on the live lever. The stirrup 8 has formed upon one side of it a sleeve, 7, into which fits the free end of the connecting-rod 5, so that the rod may have a sliding connection with the stirrup and the dead lever. The stirrup carries an automatic gripping device similar to that carried by the fulcrum block for the dead lever, except that it is arranged to permit the rod to slide freely through the stirrup in the opposite direction to that of the movement of the fulcrum block.

The operation of the apparatus is briefly as follows: When the brakes are applied, the rod 3 and the live lever move in the direction of the arrow. It is not intended that the adjuster-rod 5 should be moved by the live lever except when slack exists in the rigging. The loose connection between the lever and the rod heretofore described—viz., the pin and slot connection between the stirrup *c* and the lever—is therefore provided. When the shoes are new and there is no slack in the rigging, the lever will move to and fro without moving the rod, the slot 6 being of sufficient length to permit this in the normal throw of the lever. When, however, slack occurs, the increased movement of the lever carries the rod 5 with it, the gripping device on the stirrup 8 permitting the free end of the rod to slide through the sleeve 7. When the brakes are released the reverse movement of the lever 2 pushes back the rod 5, but at this time the shackle 9 binds upon the surface of the rod and grips it firmly to the stirrup, causing the dead lever 1 to move back with it. As heretofore described, the fulcrum carrying block for the dead lever is free to move outward along its supporting bar, and the thrust of the adjuster-rod 5 on the return stroke of the live lever 2 causes the dead lever to push the fulcrum in the direction of the arrow in fig. 1. These movements are repeated at every application of the brakes, but the adjuster rod and the dead lever are operated only when there is slack in the rigging.

Howard Hinckley, of Trenton, N. J., is the inventor. His patent is No. 531,034, and dated December 18, 1894.

### BEGTRUP'S ENGINE CROSS-HEAD.

Figs. 5 and 6 represent a method for adjusting the shoes or slides of cross-heads designed by Mr. Julius Begtrup, of Ridgway, Pa.

*A* represents a cross-head of any approved construction, *B* is a piston-rod, and *C* the connecting-rod.

*D* are the shoes or bearings adapted to work in suitable ways or guides (not shown).

*E* represents oppositely projecting ears attached to the cross-head, having suitable bearings for an eccentric bolt, *G*, which passes through the ears and through an opening, *G*, formed in the shoe. The shoes are adjustably set in and out from the cross-head by means of the eccentric bolt *G* being

FIG 5

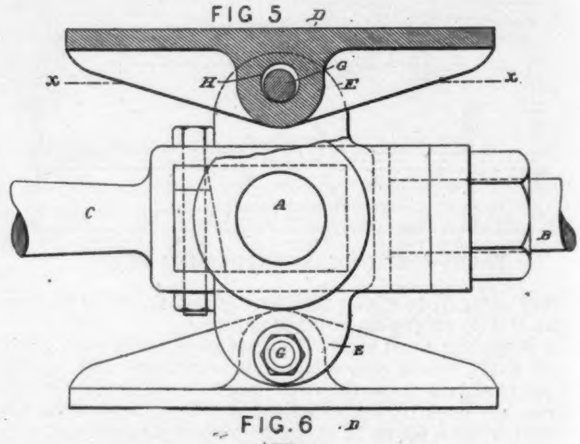
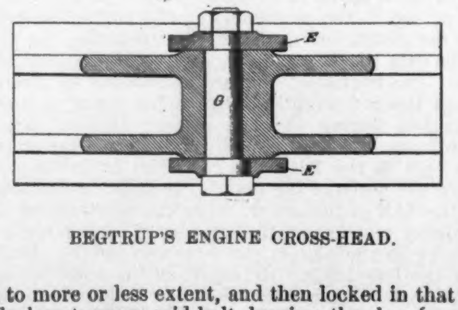


FIG. 6



BEGTRUP'S ENGINE CROSS-HEAD.

rotated to more or less extent, and then locked in that position by the lock-nuts upon said bolt, leaving the shoe free to oscillate upon the bolt.

In the cross-head shown in the present drawings each shoe is adjustably set by means of a single eccentric bolt, and the shoe has a rocking bearing adjustment in addition upon said bolt; but if desired, the shoe may not have a rocking bearing, and it may also be adjustably set by means of more than one bolt *G* for each shoe.

The patent is December 4, 1894, and is numbered 530,320.

# AERONAUTICS.

UNDER this heading we shall hereafter publish all matter relating to the interesting subject of Aerial Navigation, a branch of engineering which is rapidly increasing in general interest. Mr. O. Chanute, C.E., of Chicago, has consented to act as Associate Editor for this department, and will be a frequent contributor to it.

*Readers of this department are requested to send the names and addresses of persons interested in the subject of Aeronautics to the publisher of* THE AMERICAN ENGINEER.

## AERONAUTICAL NOTES.

**A Snap-shot at a Gull.**—Whoever has watched a soaring bird floating in the sky, riding upon the wind on rigid wings, and gliding about in all directions with scarce a change of attitude, must have wondered how he manages to set at apparent defiance all the laws of gravity and of motion, and longed to possess photographs of the bird in order to study his attitude at leisure.

A SNAP-SHOT AT A GULL.

Unfortunately the taking of such photographs is exceedingly difficult. The bird flits so rapidly, he is generally so far off, there is so seldom any neighboring object to guide the eye in judging of dimensions and positions, and the effects of perspective so frequently distort the attitude, that numerous as are the soaring birds at sea or in southern latitudes, adequate photographs of them are very rare.

We, however, engrave herewith "a snap-shot at a gull," taken by a young lady with a kodak camera, upon one occasion when all the surrounding circumstances were just right.

**A Balloon Tour.**—In the latter part of September of this year Mr. M. Mallet, the aeronaut who succeeded in 1892 in maintaining himself for 36 hours in the air in a balloon, and Mr. W. de Fonvielle, the veteran author and aeronaut, undertook what they called a tour of France by balloon, traveling by a series of ascents.

The balloon was of 37,500 cub. ft. capacity, weighing with its appurtenances 660 lbs., and capable of carrying three passengers. It was provided with an auxiliary storage balloon of 2,100 cub. ft. capacity, from which to replenish the main balloon, and also with the aerial screw invented by Messrs. Mallet and Langlois, to raise and lower the balloon, so as to economize ballast and gas.

A preliminary trip was made in the night of September 14. The wind was not in the desired direction, and, being violent, the aeronauts were blown 286 miles in about 10 hours, landing not very far from La Rochelle, whence they went back to Paris after emptying their balloon.

They started out again on September 19, and were blown about 40 miles northward, when they landed for the night. They started up again the next day, but went only a few miles in consequence of light and baffling winds. The next day rain set in, and for the next three days, although ascents were made daily, little progress was accomplished, the winds being so light and baffling that the aeronauts never got more than 100 miles from Paris. The seventh day they gave it up, and returned home determined to try it again later. The aerial screw was tested once, and found to raise and lower the balloon; but as it is rotated by hand, its use was found to be a good deal like work, and it was landed after the trial test.

Upon the whole, it may be doubted whether anything like a tour can be made by a balloon. It is the sport of the wind.

**Paris Captive Balloon for 1900.**—The French have had captive balloons at all their international expositions, and have demonstrated the fact that these can be so safely operated that they form popular and profitable attractions, no less than 15,000 passengers having made the ascension in the comparatively small captive balloon of 1889, without the slightest accident, and this balloon having subsequently made a free voyage with 20 passengers.

The following compilation shows the principal data pertaining to these captive balloons.

CAPTIVE BALLOONS IN PARIS.

| YEAR. | Diameter. | Cubic Feet. | Passengers. | Height. |
|---|---|---|---|---|
| 1867....... | ? | 176,000 ? | 12 | 820 ft. |
| 1878....... | 118 ft. | 883,000 | 42 | 1,640 " |
| 1888....... | 59 | 107,800 | 14 | 1,400 " |

Now the French are proposing to have a much larger captive balloon at the Exposition of 1900, and Messrs. L. Godard, E. Surcouf & J. Courty, aeronautical engineers, have designed one 144 ft. in diameter, to contain 1,590,000 cub. ft. of hydrogen gas, and to ascend to a height of 1,950 ft. with 160 passengers. It is to be controlled by a cable decreasing in diameter from 3.93 down to 4.71 in. in diameter, wound upon a drum by a steam-engine of 600 H.P. All the parts, including the universal pulley under which the cable passes, are designed with a factor of safety varying from 4 to 6.

The balloon is to have an internal air-bag, which is to be kept more or less distended, in order to maintain a uniform pressure upon the gas, so as to prevent deformations of the external envelope when variations occur in the volume or density of the gas.

The clear atmosphere of wood-burning Paris is particularly favorable for captive balloons, and it is to be hoped that this will be more fortunate than the captive destroyed in Chicago in 1893.

## FLYING EXPERIMENTS.

*To the Editor of* THE AMERICAN ENGINEER:

Since the appearance of my article in the January number of your magazine, I thought it well if I would indicate the lines of my investigations. I have employed a surface of 200 sq. ft. in area, stretched on a bamboo frame, all in one piece and weighing 50 lbs. I have sailed a few feet, but not from any great height. My experience resulted the same as others who have sailed from greater elevations—*i.e.*, it must be propelled, as the wind cannot be depended upon as a motor. I concluded that if the above surface was cut up into strips about a foot wide and spaced a foot apart, extending out on each side of the operator like the wings of a bird, it would give greater lift in ascending currents of air, and less resistance to advance; with a narrow tail extending back would give equilibrium, but this latter would be attained only when the machine is advancing. Now in order to propel, I thought that by running and jumping into the breeze I could continue the motion of springing up and down after I left the ground, and so propel. The result of my experiments proved that I must first lift, then propel, and continue advancing to obtain equilibrium, regardless of whether the wind blows or not, or the place of starting is rough or smooth, before I could hope to evolve a successful machine which would go under all

conditions. I don't believe mathematical formula will help in this any more than it will help to ride a bicycle.

I will give results of present experiments later on.

CHARLES ZIMMERMAN, M.D.

FREDERICK, MD., January 14, 1895.

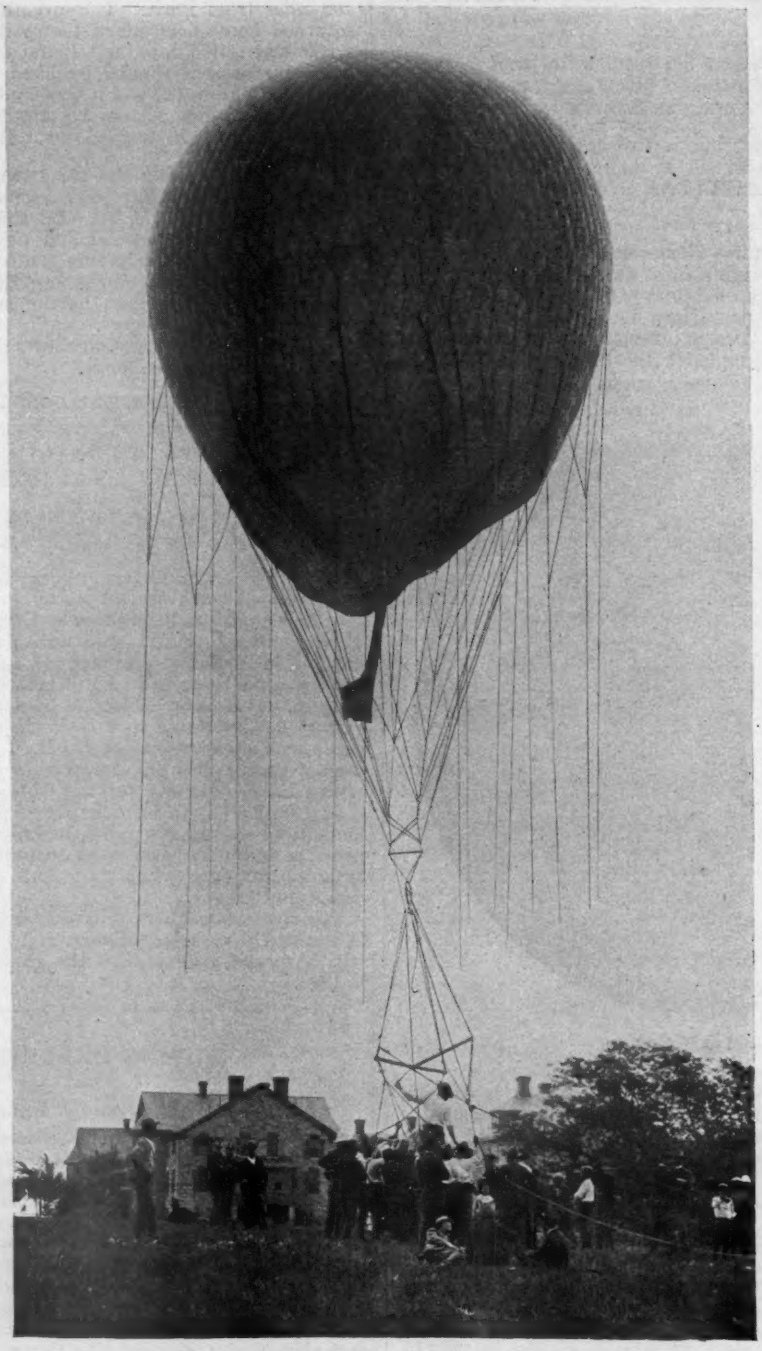
## UNITED STATES WAR BALLOONS.

THE balloon park of the United States Army, or the headquarters for experiments and practice, is at present located at Denver, Col. The view which we give herewith is of the balloon ready for an ascent.

Efforts are now being made to get the needed authority for the construction of another balloon, and the following particulars in relation thereto are taken from the *Rocky Mountain News*, published at Denver. That paper says:

"General McCook has taken an active interest in the development of the signal service, as exemplified by Captain Glassford and his corps of assistants, and he is now urging the appropriation of a special fund for advancing the service. Before he retires from office, next April, the general desires to see a new war balloon in complete working order. Plans have been made by which the airship can be built in Denver at a cost of about one-third of that required in the manufacture of the *General Myer* in France. Captain Glassford estimates that, with the assistance of Sergeant Baldwin, he can turn out the balloon c.mplete for $700. No such balloon as is contemplated has ever been made on this side of the Atlantic, and the process will be watched with great interest by aeronauts in all parts of the country.

"The object of having two war balloons in the signal corps is for the purpose of making exhibitions at different posts where the army is located, and giving signal men an opportunity to learn how to operate the balloons at different elevations and under various circumstances. Applications have been made at Washington by heads of the signal departments at San Antonio, Tex., and San Francisco, Cal., asking that the *General Myer* be sent to those points to be tested by the specialists of the department. The question at once presented itself, that if the balloon park is to be permanently located at Fort Logan one balloon could not fill the requirements, and it would be necessary to have at least two balloons at the command of the department if the field is to be satisfactorily covered. The plan which General McCook favors is for one balloon to be kept at Fort Logan and its companion to be sent over the country in charge of a competent officer. The hydrogen gas for inflating the balloons is to be manufactured at Fort Logan and shipped in iron cylinders to points where the perambulating balloon is on exhibition. The apparatus for manufacturing the gas is almost complete, and the first shipment of gas will be made in a few days. The tubes will be sent to Fort Riley, where the *General Myer* has been kept until experiments can be performed before the cavalry and artillery school. At the conclusion of the tests the balloon will be bundled up and sent to Denver, where it is to be permanently located."



A UNITED STATES WAR BALLOON.

The officers in charge of the balloon corps have, of course, kept themselves informed of all the experiments and investigations which have been made in aeronautical matters, and Captain Glassford, who is in charge of the United States balloons at Denver, is reported to have given as his opinion, after years of study of the subject, that the aeroplane will finally prove to be the solution of the vexed problem. The French dirigible balloons have not attained a perfection that entitles them, in the opinion of Captain Glassford, to serious attention when compared with the airship that has been developed by Maxim. The experiments of Maxim prove that a machine can be made sufficiently powerful and light to lift itself into the air. The experiments also prove that the aeroplane will lift a great deal more than a balloon of the same weight, and that it can be driven through the air, by means of a screw propeller, at a great rate of speed. Mr. Maxim takes the position that if the French balloon experts had spent half the money on aeroplane experiments that they have expended in fruitless attempts at making dirigible balloons, the flying machine would be as common as the torpedo-boat. The one feature in experimentation which Maxim has not reached is the attempt to steer the aeroplane through the air. In Sergeant Baldwin, who has had years of practical experience in riding in balloons and taking parachute flights through the air, Captain Glassford thinks he has a man who is especially adapted to make the supreme test. Captain Glassford furnishes the technical knowledge, and Baldwin puts the plans into execution.

Our Denver contemporary is authority for the statement that Captain Glassford "hopes to be able to take up the flying machine at the point it has reached through the remarkable experiments of Hiram S. Maxim, and build a machine that

will carry a navigator through the air and at the same time will be under full control."

## ON THE PROBLEM OF AERIAL NAVIGATION.

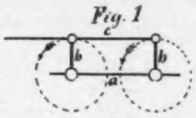
In our last issue we published an article by William Bosse on this subject, in which a reference was made to engravings that were inadvertently omitted. We therefore reprint that portion of Herr Bosse's article referring to the engravings, together with them.

This constitutes the wing-frame, which is now covered with some light stuff, which latter must project somewhat over the rear end of the ribs; such wing surface being intended to yield to the air pressure more and more toward its rear edge. Of course the coupling-rods are not covered, as that would interfere with the free display of the elasticity of the wing surface. If now this pair of wings—one on each side of the vehicle—is so connected with the treadle that with the downward movement of the treadle the wings are also moved downward, the main requirements of the system are given.

The accompanying drawings illustrate the intended wing motion as follows:

Fig. 1, *a* is a rigid portion of the wagon; *b b* are two equal cranks, rotating as indicated, and raising and lowering the bar and "wing-carrier;" *c*, which, while in motion, remains parallel to the ground plane.

Fig. 1



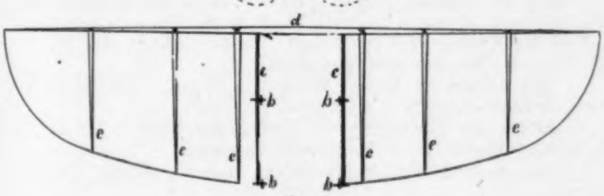




Fig. 2

Fig. 2 shows the wings on both sides of the wagon, to wit: *b b*, the crank pins (?); *c c*, the "wing-carriers;" *d*, the cross-beam, or main wing-arm, to which the wing-surfaces are attached, and extended over the elastic ribs *e e*.

The surfaces are slightly curved upward, but, owing to their elasticity, are deflected upward during the down-stroke, so that a considerable component of the "push" causes the wings to rise again, under the influence of the forward motion, like a kite inclined at a very small angle; this play continuing on and on.

## SOARING FLIGHT.

Although I do not take the same view in explaining the flight of soaring birds as Professor Langley so ably advanced in his article on the "Internal Work of the Wind," I would nevertheless like to suggest that Professor J. B. Johnson has allowed a very considerable error to creep into his discussion of the paper. If we make the same assumptions, a wind alternating between 25 and 35 miles per hour every 10 seconds, and an average acceleration and retardation in the bird's speed of 1 ft. per second, it is then quite true that the *relative velocity varies from nothing to five miles per hour, and that its average is about three miles per hour*. This much is quite correct, but the *sustaining value* of that relative wind is not equivalent to a wind of only 3 miles, because the sustaining value of two winds does not vary as the first power of their ratio, but as some higher power, which possibly exceeds the square, and therefore that relative 3 miles is equivalent to a wind of $\sqrt{33^2 - 30^2} =$ 13.75 miles per hour in its sustaining effect.

Now, an albatross is generally believed to be able to breast and advance against a gale of 60 miles an hour. I will not guarantee that such is the case; but admitting that soaring birds can move from place to place at a speed of 30 miles or more, it is quite possible that if their irregular course were measured in reference to the air, their speed would be something near 60 miles an hour. Under such circumstances the tilt of the wing would be very slight indeed, and the ratio of the resistance to the lift would probably be less than one-fortieth, even though the weight of the bird exceeded 2 lbs. per square foot. If we assume the bird travels at this speed, and any wind be blowing which changes velocity by 10 miles every 10 seconds, also assume, as in the previous case, that the acceleration and retardation of the bird is 1 ft. per second, and that the average relative difference of wind amounts to 3 miles per hour as in the previous case, then the sustaining value of that wind becomes not less than $\sqrt{63^2 - 60^2}$, or 19.2 miles an hour.

Roughly speaking, this might account for 30 per cent. of the power required in flight; the balance, judging from the peculiar buzzing noise made by soaring birds in flight, is possibly furnished by a very rapid but almost invisible motion of the pen feathers of the wing. A. M. Herring.

## "PROGRESS IN FLYING MACHINES," BY OCTAVE CHANUTE.

**Published by "The American Engineer and Railroad Journal," No. 47 Cedar Street, New York.**

(From *L'Aeronaute*.)

During the twenty-seven years that I have had charge of the editorial work of *L'Aeronaute* it has been my privilege to publish the description of many kinds of apparatus designed for work in aerostatics and aviation; I have published many scientific papers, written by authors among whom may be found the names of the most eminent scientists of our day, and certainly this has been a cause of great satisfaction to me.

I have had a certain desire for a long time—I would have liked to publish consecutive tables of all the works that have appeared during this long period of time. My old friend, Gabriel de la Landelle, has often tormented me with this refrain:

"My dear friend, you ought to publish every ten years an indexed table of all your articles, in order to render them easy of access to those in search of information."

I have always replied that I had no time to do such a piece of work as that; and if some young man would undertake it I would give him my heartiest encouragement.

La Landelle would say: "Ah! if I were only young I would undertake this task."

But La Landelle is dead, and nobody seemed desirous of undertaking such a burden, when I received a book which has in some ways taken the place of the work which I desired, at least in that portion of it which touches the apparatus of aviation.

Mr. Octave Chanute, President of the Congress of Civil Engineers, and of the Aerial Conference held in Chicago, has just published a book regarding the numerous attempts which have been made in the construction of apparatus for aviation.

Mr. Chanute had found in *L'Aeronaute* the greater portion of the documents which he publishes, where he has done better than merely make a catalogue of them, in that he has added his own personality and has done his work with the persistency of a convinced aviator and an engineer of the highest merit.

Unfortunately his work is written in English. I hope, nevertheless, that Mr. Chanute, who speaks and writes French, would be willing to make the translation of his work into our language, and do it himself. Mr. Chanute's book will be of the greatest advantage in the study of aviation, but it will be particularly useful to me.

I very often receive visits from inventors who declare that they have found the solution of the problem. Ninety-nine times out of one hundred the invention is public property; and sometimes when I tell this to the inventor he assumes a very lofty attitude in saying, "But how can you prove it to me, sir, that my idea has already been published?" In order to do this it would be necessary for me to make a search through the files of *L'Aeronaute*. I have not done this for want of time; and the inventor has gone away convinced that I have been merely desirous of preventing progressive men from bringing out their ideas and of discouraging them.

But the thing will be more simple now. I have only to open Mr. Chanute's book to point out the description and the design of the apparatus to the *soi-disant* promoter. It is true that this method may not always succeed.

Three years ago I received a visit from a gentleman who announced that he was going to abolish taxes, suppress war,

etc. (this is the usual formula), by means of a flying machine which he had invented.

I asked him if he had any intention of deriving the usual benefits of this invention by taking out a patent. He declared he would be an idiot if he did not derive some benefit from so marvellous an idea, and furthermore he had children, and that he was resolved to leave them an immense fortune.

I tried to make him understand that his invention was not patentable, for it had been described a long time previously in a number of *L'Aeronaut*, dated fifteen years back.

He cried : "What! because some clown has caused an article to appear in your paper which is more or less like mine, cannot I, a citizen, an influential elector, have an idea patented which would give power and glory to my country and fortune to myself? But in such a case as that your paper is a danger to all the world and ought to be burned in the public square at the hands of the executioner. Furthermore, I am resolved not to follow your advice. I am going direct to my patent agents, who have promised to get my invention patented. When that is accomplished, I will go to the Government, and from them I will demand three million francs and the Cross of the Legion of Honor. If the Government will not accept this proposition I will exploit my patent myself."

And he went away and never came back. But I learned afterward that he spent all his property in patents and fruitless attempts, and that he was in deep dejection.

Another instance less sad than that occurred more recently. We know that Gabriel de la Landelle, in his treatise on aviation ("Traité d'Aviation") published the design of a projected aeroplane raised in the air by vertical screws and propelled by horizontal screws. A short time afterward a certain journal attributed the idea of a similar apparatus to an inventor of whom it had a great deal to say. A few days afterward another journal published an indignant letter from a man who claimed that he had flown, and that the invention was his.

Mr. Chanute's book will do away with cases where money is wasted in fruitless experiments, and especially in patents and taxes, which the State imposes upon people who think they have discovered something. It is very certain, if we could have all the money that has been spent in patents for aeronautical devices, we would have enough to solve the problem.

Mr. Chanute begins with the history of mechanical birds, then he touches helicopters, and finally aeroplanes. All of his descriptions are made complete by engravings, taken for the most part from *L'Aeronaute*.

This work is an instrument for important study ; it is condensed into 300 pages, and is edited by a man whose competency nobody can doubt. Nevertheless, Mr. Chanute, sharing in the general opinion prevailing in England and America, shows his preference for the aeroplanes. M. du Hauvell a long time ago demonstrated this idea mathematically ; but M. Veyrin, by his recent experiments, has given an impetus to the theory of aeroplanes.

We know, since Launoy and Bienvenu (1792, Académie des Sciences) that an apparatus can be raised vertically into the air by means of screws expending a force of 6 kilogrametres per kilogram.

We know that screws on a horizontal shaft can propel an apparatus horizontally by expending a force increasing as the cube of velocity. As I have already said, Gabrielle de la Landelle desired to use horizontal and vertical screws at the same time ; but a casual examination will show that vertical screws, by becoming useless after leaving the earth, would be extremely detrimental in presenting a very large surface to resist advancement. The desire has therefore been to replace the ascensional screws by a large suspending plane.

Recent calculations demonstrate that the resistance to the advancement of these planes by an enormous surface would be almost as great as that produced by elongated balloons.

M. Renoir proposed in 1872 to use oblique screws (*L'Aeronaute*, January, 1873, page 23), but never put his idea into execution. Then M. Veyrin has shown practically that by inclining a vertical screw and by a system of displacing the centre of gravity we can obtain with this oblique screw a high horizontal velocity. Then what good comes from embarrassing one's self with the immense surfaces of aeroplanes, when by simply changing the construction of the screw we can attain the same results?

I do not think that inclined screws (Vaillent) are worth as much as flapping wings. I do not say more than that M. Veyrin has demonstrated that his apparatus has the same chance of success with actual motors (he does not think so himself) ; but it seems to me that he has demonstrated that he ought not to trouble himself any more with aeroplanes having screws on a vertical shaft.

ABEL HUREAU DE VILLENEUVE.

## RECENT AERONAUTICAL PUBLICATIONS.

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON AERIAL NAVIGATION, held in Chicago, August 1, 2, 3 and 4, 1893. THE AMERICAN ENGINEER AND RAILROAD JOURNAL, 47 Cedar Street, New York. 429 pp., 5¾ × 9 in. $2.50.

This volume contains the reports of the proceedings of this Conference, which were first published in AERONAUTICS, and includes the following papers, with discussions of many of them :

Preliminary Address of the World's Congress Committee on an International Conference on Aerial Navigation.

Opening Address. By O. Chanute, C.E.

The Problem of Aerial Navigation. By C. W. Hastings, Civil Engineer, deceased.

The Internal Work of the Wind. By S. P. Langley, Secretary of the Smithsonian Institute, Washington, D. C.

Anemometry. By S. P. Ferguson, Blue Hill Meteorological Observatory.

The Air Propeller. By H. C. Vogt, Naval Experimenter, Copenhagen, Denmark.

The Elastic Fluid Turbine as a Motor for Aeronautical Use. By J. H. Dow, Mechanical Engineer, Cleveland, O.

Notes on Materials of Aeronautic Engineering. By Professor R. H. Thurston, Director of Sibley College, Ithaca, N. Y.

Flying Devices. By G. Crosland Taylor, F.R.G.S. and A.I.E.E., Helsby, England.

Atmospheric Gusts and their Relation to Flight. By Professor A. F. Zahm, Professor Nôtre Dame University, Nôtre Dame, Ind.

Sailing Flight. From Observations made at Constantine, Algeria. By J. Bretonnière, Engineer and Observer, Constantine, Algeria.

Theory of Sailing. By W. Kress, Vienna, Austria.

Soaring Flight. By E. C. Huffaker, C.E., Bristol, Tenn.

Theory of Soaring Flight. By Ch. de Louvrie, Engineer, Combebizon, France.

The Mechanics of Flight and "Aspiration." By A. M. Wellington, Member Am. Soc. C. E.

On the Action of Birds' Wings in Flight. By B. Baden Powell, Lieutenant Scot's Guards, England.

Notes on the Designing of Flying Machines. By J. D. Fullerton, Major Royal Engineers, England.

Aeroplanes and Flying Machines. By W. Kress, Vienna, Austria.

Note on an Elastic Screw. By W. Kress, Vienna, Austria.

The Advantage of Beating Wings. By Ch. de Louvrie, Engineer, Combebizon, France.

Stability of Aeroplanes and Flying Machines. By Professor A. F. Zahm, Nôtre Dame University, Nôtre Dame, Ind.

Flying Machines, Motors and Cellular Kites. By Lawrence Hargrave, Experimenter, Sydney, N. S. W.

Suggestions and Experiments for the Construction of Aerial Machines. By F. H. Wenham, Engineer, Goldsworth, England.

Methods of Experimentation. By A. P. Barnett, Experimenter, Kansas City, Mo.

Learning How to Fly. By C. E. Duryea, Mechanical Engineer, Peoria, Ill.

A Programme for Safe Experiments. By L. P. Mouillard, Observer, Cairo, Egypt.

Experiments with Hexagon and Tailless Kites. By W. A. Eddy, Experimenter, Bayonne, N. J.

Some Experiments with Kites. By J. Woodbridge Davis, New York City.

Manufacturing Hydrogen Gas Balloons. By C. E. Myers, Aeronautical Engineer, Frankfort, N. Y.

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Balloon Meteorology. By C. E. Meyers, Aeronautical Engineer, Frankfort, N. Y.

Scientific Results Gained by Balloons. By H. A. Hazen, Weather Bureau, Washington, D. C.

Explorations of the Upper Atmosphere. By N. de Fonvielle.

Ten Miles above the Earth. Discussion by H. A. Hazen.

Appendix containing discussions of some of the papers.

The above volume is now ready for delivery.